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CANCER OF THE THYROID AND ITS PRESENT-DAY TREATMENT

EMBODYING THE EXPERIENCE OF THE MEMORIAL HOSPITAL OF NEW YORK

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RECENT reports in the literature of cancer of the thyroid, chiefly from German and American sources, are considerably at variance in regard to the method of choice and the results of treatment of this condition. Some in Germany have noted recently a movement in favor of radiation of malignant goitre, similar to that which has already taken place in the case of cancer of the cervix of the uterus,[30] while others relegate radiation to a very insignificant rôle as a sort of placebo treatment of advanced hopeless cases.

In view of some interesting points discovered in a study of 33 cases treated at the Memorial Hospital, it appeared worth while to review the literature in order to collate some of the more remarkable features of this disease and to bring together the conflicting statements of various writers in the hope that thereby the present situation may be somewhat clarified. This partial review of the literature, together with a report of the cases treated at the Memorial Hospital, constitutes the subject-matter of this article.

Because of the marked variations in the structure of thyroid tissue, both normal and neoplastic, depending upon functional activity and various other factors, special standards [18] are required in the interpretation of its tumors, which do not apply elsewhere. The malignant qualities of a thyroid tumor must be judged less from the microscopical appearances and more from the clinical aspect. Allen Graham says:[20] "So far as diagnosis is concerned, it makes very little practical difference what the tumor looks like under the microscope. . . . The malignancy depends upon the tendency or capacity of the tumor to invade locally, cause local destruction, give distant metastases, and finally to result in the death of the patient. . . . Local invasion is the most important index of malignancy."

Much is written about sarcoma of the thyroid, but Ewing [18] finds that the mesoblastic origin of most of the sarcomas reported in the literature is highly improbable, and that the occurrence of true sarcoma of the thyroid in man still requires demonstration.

Etiology. Long Duration of Prëxisting Goitre.—Practically all writers, with the exception of Bloodgood, emphasize the frequency with which a

malignant tumor of the thyroid is preceded by a long-existing enlargement of the gland. Bloodgood,[5] writing in 1906, found in 9 cases of cancer of the thyroid a history of goitre earlier in life in only one case. On the other hand, Balfour [2] of the Mayo Clinic, in 1918, stated that in his experience he had not met with a single case which gave unmistakable evidence of having developed within a normal thyroid. He believes that "an incontrovertible argument for operation in cases of adenomatous goitre is the fact that cancer is practically not known to have developed in a healthy thyroid gland. Pre-existing disease has always been in evidence, so that adenomatous goitre may be looked upon, to a certain extent, as a precancerous condition."

L. B. Wilson,[58, 60] at the Mayo Clinic, found in 1921 that of 290 malignant goitres, 159 had an enlargement of the thyroid for five years or longer, and 229 for more than one year. He states [60] that many cases apparently start as adenomas in the third decade and progress very slowly. "Thus, while a sudden increase in rate of growth of a long-standing nodular tumor of the thyroid in a patient more than thirty-five years of age is strongly indicative of beginning malignancy, a slow continuous growth of a nodular tumor may be almost equally indicative of the same condition."

Müller and Speese [42] found that 53 per cent. of their cases gave a history of a previous goitre, and that in over one-half of these cases the goitre had existed for more than ten years. Combining their figures with those of Ehrhardt they found the duration of previous goitres as follows:

1 to 10 years, 33 cases	30 to 40 years, 9 cases
10 to 20 years, 21 cases	40 to 50 years, 3 cases
20 to 30 years, 16 cases	

Speese and Brown,[61] in a study of 28 cases, found a history of preëxisting goitre in 22, or 78.5 per cent., with the following distribution:

3 years, 1 case	15 years, 6 cases
6 years, 2 cases	18 years, 1 case
10 years, 3 cases	20 years, 1 case
13 years, 1 case	

Simpson [50] states that 90 per cent. of the carcinomas spring from preëxisting goitre. Trotter [55] thinks that carcinoma never appears except in a gland previously abnormal, while John Rogers [47] has stated that clinically he has observed two varieties: one type developing extensively throughout the greater part of a long-standing simple goitre, with early involvement of lymphatics, the other type originating and remaining in some localized portion of an otherwise healthy gland, being hard and nodular, and involving lymphatics very late.

J. Tate Mason [38] reports a carcinoma in a man of fifty-nine who had first noticed a small lump in the thyroid soon after he had been strangled in a fight when only sixteen years old. This lump remained stationary in size for twenty years, then for two years it enlarged until it reached the size of a lemon, again remaining stationary in size for twenty years, having begun again to enlarge one year previous to Mason's observation.

Kraus [36] relates the history of a man of sixty-seven who first noticed a goitre twenty-nine years before, and who during a period from 1899 to 1913 had three operative removals, followed each time by a recurrence. He states that most cases have had a goitre for ten years or longer.

Klose and Hellwig [39] comment on the long duration of preëxisting goitre in many cases, mentioning one case that had a goitre for twenty-six years, and express the opinion that malignant struma is most frequent in the fifth decade, not only because cancer is a disease of middle and old age, but also because in these years the nodules of nodular

goitres are in their stage of maturity and degeneration. They find that in their locality (Schmieden's Clinic at Frankfurt), cancer begins almost exclusively in the right lower pole, and state that similar observations, though not so pronounced, were made by Bossart. Their explanation is that in general the growth of the nodules of a nodular goitre begins in the right lower pole, and that therefore it is there that the largest and most degenerated nodules are found. Delore, Lucke, Carrel-Billard, and Lartigau are cited by Speese and Brown [51] as laying much stress on the etiologic significance of benign growths. Bland-Sutton [4] states that cancer of the thyroid is more liable to attack a diseased thyroid, and in common with many other writers mentions the oft-repeated statement that cancer of the thyroid is more common in endemic goitre regions.

Allen Graham [19] states that 95 per cent. of the malignant growths of the thyroid are carcinoma, and of these fully 90 per cent. arise from fetal adenoma, passing through the stage of "malignant adenoma." He finds a small number of carcinomas not dependent upon adenomata for their origin, most frequently papillary carcinoma, which, according to him, seems to originate in papillomatous processes found in non-adenomatous as well as in adenomatous (not necessarily fetal) thyroids.

Finally, Ewing [18] states that fetal adenoma may give origin to adenocarcinoma, carcinoma and many so-called sarcomas; it arises early in life and appears as a definite tumor usually before the twentieth year. Under the caption adenocarcinoma or malignant adenoma he states that the appearance of the tumor is usually preceded by a period of slow enlargement of the gland which may extend over several years. Again, under papillary epithelial tumors, some of which are malignant, they "are usually preceded by chronic enlargement of the thyroid and growth is relatively slow." Under carcinoma, he states "most cases arise in goitrous glands."

The slow growth in some cases of thyroid cancer suggested to Chambers [11] that in many instances the condition is one of continuous slow development of a malignant goitre, rather than a malignant growth superimposed upon a benign one. Ewing, on the other hand, states that the usual clinical history indicates that a long period of benign overgrowth precedes the malignant tumor, and that there are many indications that tumors of the thyroid, as in many other organs, fall into two groups, embryonal and adult, and that each variety includes some forms of adenoma and carcinoma. He thinks that some atypical, usually rapidly growing tumors, described as sarcoma, appear to find their true explanation in an embryonal epithelial origin.

Acute Carcinoma.—In contrast to slow growth of thyroid carcinoma some have described an acute form of cancer. Ewing has observed two very acute cases in young women. Moure and Liébault [41] cite a case in a man of fifty-nine, in whom within three months a large tumor simulating Riedel's woody strumitis developed. In this case, however, it proved to be an infected carcinoma. At the onset he had a severe cold, and they raise the question whether the infection did not stimulate a previously latent cancer. Bouman [7] also mentions acute thyroid carcinoma.

Rôle of Infection.—Bouman also discusses the relation between infection and the development of thyroid cancer. He quotes Carrel-Billard as follows: "At the Lyon Clinic the patients often observe some infectious disease just about the time of the development of the malignancy. Many times an enlargement of the neck starts after an attack of la grippe" . . . "This influence of infection is real," says Carrel; "we do not believe that it is a mere coincidence." Poncet in the same clinic had observed long before the existence of an intimate relationship between some inflammatory condition of the pharynx or tonsil and certain tumors of the thyroid. De Quervain [15] notes previous inflammation as a factor. Erysipelas, influenza and streptococcic septicæmia are mentioned by Speese and Brown as playing a part in the causation of some cases.

Age.—Cancer of the thyroid occurs most frequently in patients between 40 and 60, Balfour finding that of 103 cases at the Mayo Clinic, 81.5 per cent. were over 40. However, the disease is occasionally seen at much younger ages; 3 and 5 years (Ewing), 5, 11, and 16 years (Klose and Hellwig), 17 years (Meleney [38]).

Trauma.—Trauma has been accorded a place in the etiology of thyroid cancer by several writers.[18] In this connection Balfour mentions 7 cases that had been treated by injections of various irritants and by application of absorbents. (See Mason's case, developing after strangling.)

Pregnancy.—Many cases are attributed to or aggravated by gestation.[18] Speese and Brown cite Kaufman (no reference) as authority for two cases closely associated with pregnancy.

Other Factors.—Various other factors, such as carrying heavy burdens, menstrual congestion, menopause, local atherosclerotic changes in the vessels, and repeated "Einklemmung" of retrosternal nodules with attendant crushing and circulatory disturbances, are given by Klose and Hellwig.

Frequency of Cancer Found in Goitres.—Of 14,456 goitres seen at the Mayo Clinic from January, 1910, to August, 1918, Balfour found that 1.19 per cent. showed malignant tumors. He states that, as pointed out by Plummer, cancer in their experience has never been found in a distinctly and purely hyperplastic gland (exophthalmic goitre). Excluding, then, exophthalmic goitre, of the remaining 6359 cases of goitre, cancer was found in 1.6 per cent. In 1921, from the same clinic, Wilson reported that of a total of 16,549 goitres, including exophthalmic, 290, or 1.75 per cent., showed malignant tumors.

DeCourcey[14] found in 3640 goitres, of which 1242 were operated on, 16 proven and 8 doubtful carcinomas, giving a total doubtful ratio of about 0.7 per cent.

Speese and Brown in 426 lesions of the thyroid found carcinoma in 19 and "sarcoma" in 3, a total percentage of over 5.

Simpson found that 4 per cent. of all thyroids examined by him microscopically showed malignant disease.

Jackson[28] in one series of 100 cases of goitre in Wisconsin, found 4 cases of cancer.

John Rogers in 1917 stated that the disease was relatively rare in his experience, as he had records of only 12 cases.

Hueck[27] found 10 malignant tumors in 212 cases of goitre operated on (4.7 per cent.).

Jüngling[29] estimates from clinical observation that 3 to 5 per cent. of all goitres are malignant. Klose and Hellwig found 20 malignant goitres in 655 operated on (3 per cent.). Other recent German figures are as follows: Nägeli 4.2 per cent., Oberst 4 to 5 per cent., Schaedel 3.3 per cent.

Non-occurrence of Cancer in Exophthalmic Goitre.—While Balfour, Herbst,[25] and Speese and Brown state that cancer has never been known to develop in a *true* exophthalmic goitre, Ewing states that true tumors may develop in the Graves' thyroid, though rarely. He considers it possible that the initial hyperplasia belonging to the general disease passes rapidly into a malignant overgrowth, which thereafter dominates the clinical picture. However, many cases of thyroid cancer are complicated by the existence throughout their course, or before the tumor becomes apparent, or at some time during their course, by symptoms of Graves' disease, which may obscure the diagnosis.

There were symptoms of intoxication in 26 of Carrel-Billard's 83 cases,[21] and Speese and Brown observed in 5 of their 28 cases the following symptoms:

1. Rise in temperature to 38–38.5 to 39° C., which may precede the tumor. The patient becomes cachectic, and only after the lapse of some weeks is the cause (cancer) demonstrable. Fever, "more constantly found in sarcoma" than in carcinoma, is regarded as a symptom of altered thyroid function.

2. Symptoms of exophthalmic goitre.

3. Disturbances in nutrition—first, loss in weight. Urinary disturbances, either increase or decrease, are frequently met.

Klose and Hellwig find that in their locality symptoms of Basedow must be regarded as a very frequent and important initial sign of malignant change in a goitre, though they regard this manifestation as being rare elsewhere.

Incomplete Basedow symptoms were associated with one case having a small thyroid tumor with bone metastases, reported by Tixier and Duval.[84]

Sex.—In contradiction to other writers, De Quervain is said to have observed more malignant tumors of the thyroid in males. Most writers find it about twice as frequent in females, the following ratios being given: Balfour 65:35, Wilson 69:31, Müller and Speese 60:40, Orcel 14:6, Carrel-Billard 5:3, Delore 4:1, Hueck 6:3.

Pathological Classification of Malignant Goitres.—Modern American surgical literature usually considers malignant tumors of the thyroid under practically the one heading of "malignancy," or if an attempt is made to classify them, the classification is confused by retaining such terms as mixed- and spindle-cell sarcoma and small round-cell sarcoma, terms which in most cases could probably better be replaced by the name of some form of carcinoma. The following classification is proposed as an adaptation of Wilson's, arranged to show morphological relationships:

- From true thyroid tissue
  - Adult thyroid tissue (normal?) proliferating and metastasizing
    - Adenocarcinoma
    - Malignant adenoma (Subvariety): papillary adenocarcinoma
  - Embryonic thyroid tissue, proliferating and metastasizing
    - Carcinoma (Subvarieties): medullary, scirrhous, malignant papilloma, sarcoma-like forms, metastasizing colloid goitre.
- From associated or adjacent tissues
  - From remnants of lateral thyroid anlage (postbranchial body).
    - Struma postbranchialis (Getzowa) (small alveolar, large-cell adenocarcinoma)
  - From parathyroid bodies
    - Parathyroid struma (glycogen-containing struma, Th. Kocher, Jr.)
  - From thyroglossal duct and its pyramidal process, or cancer of œsophagus, or cancer of larynx, or branchiogenic cyst
    - Squamous carcinoma

Frequency of Various Varieties of Malignant Goitre.—Herbst found that of 207 malignant tumors operated on at the Mayo Clinic,

62, or 29.8 per cent., were carcinoma,
102, or 49.2 per cent., were malignant adenomas,
24, or 11.6 per cent., were malignant papillomas, and
19, or 9.2 per cent., were called sarcomas.

Clinical Differentiation of Various Varieties of Malignant Goitre.—Kocher (Sr.)[21] has given some very suggestive diagnostic points in an attempt to differentiate clinically between the various forms of malignant thyroid tumors. As such differentiations are not commonly found in the English literature, it seems worth while to reproduce them in part here:

1. *Adenocarcinoma, "wuchernde Struma" of Langhans.*—"The more a goitre presents itself as a larger, circumscribed mass, prominent on one side in spite of rapid growth, and the more distinctly it retains a certain mobility in spite of increased consistence (often with slight tenderness to pressure), *i.e.*, the less marked the attachment to surrounding structures still remains after a period of months or even one or two years, so much the more have I reason to think of the wuchernde Struma. The surface may present, also, a regular form. In further support of this diagnosis are the large arterial vessels, at times the large branches of the superior thyroid artery, which may be felt upon the tumor. It is all the more favorable to this diagnosis if marked signs of stasis in the form of dilated subcutaneous veins are not present."

2. *Malignant Adenopapilloma Cylindrocellulare.*—"The most characteristic type of this tumor is the goitre which grows slowly, forms tumors of smaller size, after excision recurs only locally, after a certain time results primarily in involvement of lymph-nodes, but possesses no great tendency to produce metastases."

3. *Carcinoma.*—"One is always inclined to consider as carcinoma a tumor of the thyroid itself which grows rapidly, is firm and knobby, only slightly movable, presents symptoms of adhesions to the adjacent organs, if there be added thereto early lymph-node involvement, which forms tumors, usually multiple, behind the sternomastoid and from there upwards and downwards."

4. *Parathyroid Struma.*—"It seems justifiable to think especially of parastruma when a firm, knobby, usually not very large tumor has developed towards the clavicle (it is, however, always unilateral and united with one of the lateral thyroid lobes), and thus is deeply situated, is fairly firmly fixed, has recently developed relatively rapidly on the basis of a slowly growing goitre, and when, together with this increase in growth, marked dyspnœa, hoarseness and dysphagia have appeared with absence or diminution of pain and adenopathy despite signs of increased fixation to the trachea."

Symptoms and Diagnosis.—In general there are no characteristic *early* symptoms of cancer of the thyroid. The difficulty of early diagnosis is strikingly shown by the fact that at the Mayo Clinic 70 per cent. were missed clinically.[22] Rate of growth is not a reliable criterion, for, as stated by Wilson, "while a sudden increase in rate of growth of a long-standing nodular tumor of the thyroid in a patient more than thirty-five years of age is strongly indicative of malignancy, a slow continuous growth of a nodular tumor may be almost equally indicative of the same condition." In 46 per cent. at the Mayo's the diagnosis of a malignant tumor was *not even considered* until the operation or the pathologist's examination revealed the true condition.[2] Balfour says this figure could be lowered if in the large group of hard or firm adenomas the possibility were regularly noted, but the total percentage of accuracy in diagnosis would thus be lowered, because of the small percentage of such adenomas that are malignant. He mentions the confusing changes in certain enlarged thyroids that are not malignant, especially low-lying adenomas in which consistence is increased by the presence of a considerable deposit of lime salts. He points out the frequent close analogy between benign nodules and malignant masses, in that both remain covered by healthy thyroid tissue until they have reached considerable size. Carcinoma of thyroid almost invariably develops from within outward.[2]

Thus, small areas of carcinoma are sometimes found in the routine pathological examination of adenomas removed at operation.[6] Yet the difficulties of pathological diagnosis in this field are well known; when the cancer has broken down, and especially when it has developed within a cyst, atypical microscopical pictures are often found, not agreeing with the surgical findings.[3] Even nodular enlargement may be absent, as Klose and Hellwig find a whole series of cases with but a uniform swelling of the gland. Hinterstoisser

collected 17 cases beginning as diffuse infiltration, and Friedland describes carcinoma without enlargement of the gland.[18]

Increased consistence may be produced by the presence of calcified or fibrous benign nodules. Kraus finds that the differential diagnosis from chronic strumitis is most difficult. In both chronic strumitis and cancer there may be fixation, radiating pains and tracheal stenosis, and he doubts whether the sign of Delore and Alamartine (involvement of both sides in chronic strumitis) is regularly present.

Oehler[42] thought in 1919 that he had discovered an additional sign of malignant goitre in the loss of the shadow of the trachea on the röntgenogram, believed to be due to the infiltration of the trachea. However, Klose and Hellwig point out that Pfeiffer has shown this sign to be unreliable, and indicative merely of antero-posterior compression of the trachea (and therefore present at times in benign tumors).

Decreased mobility is only to be demonstrated when the capsule of the thyroid has been infiltrated.[30] In one case the enlarged right lobe moved perfectly well with deglutition, but at operation a large section of œsophagus was found to be involved. The point about fixation is not whether the goitre is so fixed that it cannot freely accompany the trachea upward during the act of swallowing, but whether the goitre can be moved with reference to the trachea or other structures in immediate apposition to it.

Dysphagia, according to Klose and Hellwig, is not a result of pressure, but is due to attachment of the growth to the œsophagus, and is therefore seldom found with benign goitres, and then only when there is growth between the trachea and œsophagus. Actual invasion of œsophageal (or tracheal) lumen is rare.[48] Thus, a stomach bougie can usually be passed smoothly through the œsophagus.[22, 48]

The radiating pains, especially to the distribution of N. occipitalis major, also the second, third and fourth cervical nerves, are not an early symptom.[22, 30] Balfour finds that rarely hoarseness and dysphagia may occur early, and that in the absence of other symptoms, they are suggestive. Recurrent nerve paraylsis is the earliest sign of nerve involvement, and occurred in one-third of Schaedel's cases. The changed position of the larynx aids in producing hoarseness by the consequent circulatory changes in the laryngeal mucosa.[30] Laryngological examination may reveal posticus or total paralysis of the laryngeal muscles, or the sabre-sheath stenosis of the trachea, or infiltration of the tracheal wall; in the latter case, direct laryngoscopy is said to be dangerous.

Partial or complete palsy of the arm was seen in three cases by Schaedel. Sympathetic paralysis, producing enophthalmos, narrowing of lid aperture, contraction of pupil and paleness on the affected side, with congestion and sweating on the sound side, occurred in two of Schaedel's cases. Pressure on the vagus, leading sometimes to cardiac disturbances, is mentioned by Müller and Speese. Venous stasis and thrombosis are of common occurrence, and growth into veins may occur even with an intact capsule,[30] and even with histologically benign tumors.[18] Klose and Hellwig find that enlargement of the right heart is frequent, and they interpret it as being due partly to the obstruction to the venous circulation, and partly to changes in resistance in the lesser circulation through narrowing of the trachea.

As mentioned above, various toxic changes may be found, such as tachycardia and cardiac irregularities.

Actual cancer cachexia is rare, according to Klose and Hellwig, and loss of weight occurs only as a result of dysphagia, pains, insomnia, etc., or, in the experience of Müller and Speese, chiefly in those cases in which the primary tumor is small and the metastases considerable.

Diagnostic puncture is advised against by Klose and Hellwig, as it is often without positive result in cases of undoubted cancer, and there is at least theoretical danger of disseminating the tumor. They are also opposed to biopsy unless it is to be followed immediately by a radical operation.

Metastases.—Bland-Sutton considers that one remarkable feature of thyroid carcinoma is the infrequency with which it disseminates. However, Ehrhardt and Kocher

(cited by Schaedel) and Kraus state that metastases occur in about 90 per cent. of the cases. Usually lungs and bones are given as the most frequent sites of metastases, but Schaedel found the following distribution:

1.	Regional nodes	11 cases
2.	Hilal and bronchial nodes	8 cases
3.	Lungs	5 cases
4.	Bones	4 cases
5.	Stomach	2 cases

In this country Herbst at the Mayo Clinic finds that bone metastases are rare, and that the lungs and liver are the most common location of secondary growths. Some have believed that bone metastases may appear at points of hemorrhage following trauma,[20] but, as in other tumors, a true relation to trauma may be questioned.[13] Bone metastases may have a predominating osteoplastic character,[15, 20] and fractures occurring may heal.[15] On the contrary, Aschoff[1] states that the bone metastases have no osteoplastic tendency, destroying the bone like primary central bone tumors, and causing in the spine, for example, collapse with compression myelitis.

The route of metastasis is especially frequently through the blood-vessels, and Graham, in a recent communication,[21] advocates making use of the criterion of local invasion of the blood-vessels to distinguish malignant from benign adenomata. On that basis he has reclassified as benign, 43 adenomata which he had formerly considered malignant.

Ehrhardt[18] gives the following order of frequency of involvement of various organs: Lungs, 129 cases; bones, 66 cases; liver, 36 cases; kidneys, 20 cases; pleura, 16 cases; brain, 12 cases, and other organs, 13 cases.

Occasionally the involved regional lymph-nodes with a small primary tumor may give the clinical picture of Hodgkin's disease or lymphosarcoma of the neck, as in a case seen recently at the Memorial Hospital. Moreover, the tumor may arise in lateral aberrant thyroid tissue,[22] and thus produce one of that numerous group of cases with tumor of the side of the neck in which no clinical diagnosis can readily be made.

Metastasis to the heart, a very rare occurrence, has recently been reported by Eisen,[16] in a case having wide dissemination of the disease.

Hæmoptysis is a frequent result of lung metastasis.

Complications.—Ulceration of the trachea when invaded by the growth often gives rise to septic pneumonia, usually rapidly fatal[4, 42]: Hemorrhage, œdema of glottis, starvation from dysphagia, and suppuration of the tumor are also causes of death, and occasionally pressure due to sudden hemorrhage within the tumor may prove fatal.

Treatment.—Considerable discrepancy appears in the modern literature as to the relative value of surgery and radiation in the treatment of malignant tumors of the thyroid.

Bland-Sutton states that the very scanty literature in relation to the operative treatment is a clear indication of the hopelessness of such treatment; while in respect to the radiation treatment, A. Kocher,[22] in a recent article, states that the few publications show that the results are not worth publishing.

Perthes, who has constantly observed the effects of röntgen-ray on tumors since 1903 and has compared the results with those of surgery, and who was one of the first to oppose his observations and views to the over-enthusiastic hopes of German clinicians about the results of radiation,[26] has this to say about surgery in carcinoma of the thyroid: "As total extirpation of the thyroid is not permissible, so in most cases a real radical operation is not possible, and as far as I can see, nothing is known of a lasting cure."

The experience of Balfour and others [31] indicates that there is no hope of cure by surgery when the growth has progressed sufficiently to enable making a clinical diagnosis, and in fact DeCourcy states that in every case so diagnosed death has been hastened by operation.

A. Kocher claims 80 to 90 per cent. cures, "as in other organs," by surgery in what he terms a *real* early operation; *i.e.*, before metastasis or growth through the perithyreum. As soon as the above conditions are passed, he says, the prognosis becomes very bad, in fact worse than with malignant tumors of other organs.

When one considers the difficulties of making an early diagnosis of cancer of the thyroid and the fact that the correct diagnosis in the real early cases is more commonly made only by pathological examination of a supposed benign adenoma, the fact that many patients, perhaps the majority, with adenomas, refuse operation, and furthermore, when one takes into account the variations in the natural history of cancer of the thyroid, from slow continuous growth of a goitre to rapid enlargement of a preëxistent goitre and the very acute type, it must be evident that the attainment of any such percentage of cures of thyroid cancer *in general*, as Kocher claims must, for a long time at least, remain hopelessly utopian. Considering the actual state of the public's knowledge of medical matters and the general profession's lack of training in the clinical diagnosis of tumors, there is no question but that the majority of patients having cancer of the thyroid will continue for a long time in the future, as they have in the past, to fail to reach competent hands until a clinical diagnosis can readily be made, and therefore when it is too late to operate. Therefore the treatment of thyroid cancer may be expected to continue for some time to be the treatment of cases which the best surgeons acknowledge do badly by operation.

Let us examine in more detail what some of the results of surgery are. The common view among surgeons is that the best attack on the problem of thyroid cancer is by way of prevention; *i.e.*, to remove all adenomas, which are considered chief source of carcinoma in this organ.[28, 6, 2, 58, 59, 60, 14, 19, 20, 21, 51] However, actual removal of all adenomas would in many cases be equivalent to total extirpation of the thyroid. The common practice of removing simply the one or two large nodules which are palpable, leaving the numerous other small nodules which are not palpable to proliferate later, accounts for the frequent history of local recurrence. That the early removal of the ordinary benign adenoma is not a sure preventive of "malignant degeneration" is substantiated by Klose and Hellwig's observation of three cases of cancer of the thyroid in which such operations had been done. This contradicts the claims of leading American surgeons. DeCourcy states: "Surgery offers 100 per cent. cure in adenomata, with mortality of less than 1 per cent."

Excellent results are claimed for surgery in those cases in which no clinical sign of carcinoma is present. Of this group, Balfour reports 70 per cent. free from recurrence, even though in many such cases only the removal of one lobe or only the enucleation of an adenoma was done. DeCourcy discovered 12 certain and 8 doubtful cancers in 850 thyroidectomies for adenoma. One had a recurrence and died in 13 months, another after 2 years, one had a recurrence after 2 years but was still living, one was living and

well one year, 4 for two years, and 12 for 3 years. On the other hand, of his 4 cases in which a clinical diagnosis could be made, all died—one in 18 hours, one in 10 days, one in 6 months and one in 9 months.

A. Kocher's rather startling figures of 80 to 90 per cent. cures in real early operations apparently are based on 10 such cases which he has had under observation, free from recurrence for from 3 to 20 years!

At the Mayo Clinic, Herbst found the following results of operation: no cures in 19 cases of "sarcoma," 5 per cent. 5-year cures of 62 cases of carcinoma, 17.6 per cent. 5-year cures of 102 cases of malignant adenoma and 33 per cent. 5-year cures of 24 cases of malignant papilloma. Encapsulation of the tumor greatly favors freedom from subsequent recurrence, 47 per cent. of the encapsulated tumors as against only 26 per cent. of the non-encapsulated tumors having remained free from recurrence. Sixteen of the 19 cases of "sarcoma" died within one year after operation, the average post-operative course being 6 months. Forty-eight and four-tenths per cent. of the 62 cases of carcinoma were dead. Most (42 per cent.) died within one year. Ten per cent. of the 102 cases of malignant adenoma died of that disease after operation. Only 2 died within one year after operation, 5 having lived 5 years or more. However, 52 per cent. had recurrences, 6 occurring within one year, 13 in the third year and 15 in the fourth year after operation. Twenty-five per cent. of the 24 cases of malignant papilloma died of the disease, 4 of these during the first year, one during the third year and one during the fourth year following the operation. Only two cases had reported recurrences, one after 2 years, and one after more than 5 years.

Balfour in an earlier report had been able to secure information about 42 cases out of 63 that had been operated on. He reported as follows:

6 per cent. + operative mortality.

47.6 per cent. died from early recurrence.

11 per cent. had recurrence at the time of his report.

Total 64.6 per cent. deaths or probable early deaths.

Thirty-five per cent. had no evidence of recurrence for from one to five years (17 cases), distributed as follows:

3 cases less than one year 3 cases one to two years 4 cases two to three years	10 cases less than three years without recurrence.
1 case three to four years 5 cases four to five years 1 case more than five years	7 cases more than three years without recurrence.

Only 14.6 per cent. of those having diffuse involvement were alive without recurrence. In the 46 per cent. in which no clinical signs of cancer were found, about 70 per cent. were free from recurrence, although in this group total thyroidectomy was rarely performed, usually only the removal of the affected lobe or the enucleation of an adenoma having been done.

Crotti quotes the statistics of Brown-Potter in 1900, giving the total mortality of operation for thyroid cancer as 72 to 85 per cent., according to the stage of development of the tumor. He also gives Madelung's figures; that author in 1900 reported 100 cases. In 59 death occurred within one month after the operation, in 39 recurrence took place within six months, and in the remaining two death occurred later.

Müller and Speese in 1906 placed the mortality, including deaths from operation and from speedy recurrence, at at least 70 per cent.

Jackson in June, 1924, reported that in one series of 100 cases of goitre operated on during 1923 at the Jackson Clinic, there had been 4 cases of cancer, of whom 3 were already dead.

De Quervain is said [32, 48] to give the immediate mortality after radical operation as 50 per cent.

A. Kocher, who claims 80 to 90 per cent. cures by real early operation, states that when the conditions for what he considers an early operation have been passed, the prognosis becomes very bad, with an immediate mortality from operation of 10 to 20 per cent., and recurrences in 84 per cent. He finds that "sarcoma" recurs in 100 per cent., malignant papilloma in 33 per cent., other cancers in 90 per cent.

Klose and Hellwig, in a recent report, state that the question of the value of radiation in the treatment of thyroid cancer is certainly worthy of being thoroughly investigated, since statistics indicate at present that even with the modern refined operative technic the immediate operative mortality is 30 to 66 per cent. and the curative results of the most radical operation very poor. Of 20 cases which they operated on, the 18 who had no radiation were all dead within a year.

Among the dangers of operation Balfour mentions œsophageal fistula, tracheal collapse, injury to nerve supply of the laryngeal muscles, secondary œdema of tracheal mucosa and secondary hæmatomas.

Sudeck [52] has never succeeded in completely removing a cancer of the thyroid without total extirpation of the gland, thereby injuring the parathyroids, and he experienced one such case which died of tetany. In view of results which he has seen following radiation of malignant tumors of the thyroid, he therefore makes no attempt at surgical treatment, but considers it quite justifiable to treat every case by röntgen-ray.

Treatment by Radiation.—Leading German radiologists agree that carcinoma of the thyroid is remarkably sensitive to radiation. Perthes also states that "sarcoma" of the thyroid is as favorable for this form of treatment as sarcoma of lymph-nodes or tonsils; though Schaedel's experience leads him to think that "sarcoma" of the thyroid does not react well to radiation "whether of spindle-cell, polymorphous-cell or lymphoid-cell type." Only one of his cases of "sarcoma" showed softening and regression of the tumor but he admits that the cases of "sarcoma" came too late and in poor general condition.

Schaedel's report in 1922 is one of the most important recent contributions to this subject. He considers that thyroid carcinoma is so radiosensitive that a therapeutic-diagnostic test by radiation is of great value. If the tumor is a carcinoma, according to Schaedel, one can tell in two to three weeks after radiation merely by the rapid change that takes place, the tumor becoming softer and smaller. He finds that the primary tumor appears more responsive than the metastases. In all but one case he secured permanent regression of the primary tumor. The one case having local recurrence had only one series of röntgen-ray treatments. However, even the secondary tumors showed some response; in 3 out of 5 cases of lung metastasis the shadows in the röntgen film became so reduced that they could no longer have been recognized as metastases. Lymph-node and bone metastases were no longer demonstrable.

He reports 15 cases of carcinoma of the thyroid treated by röntgen-ray. Of these 11 were inoperable, 7 being so advanced that one would have given a prognosis of only weeks or months. Of these 7 hopeless cases, 2 died within 2 weeks of intercurrent diseases (one of pneumonia, and one of sepsis from perforation of the œsophagus); but the other 5 averaged one and three-quarter years before dying of metastases, living 8, 10, 13 and 17 months in good health.

Of the four less hopeless inoperable cases one died quickly of brain metastasis, one lived three and one-fourth years, going for periods of 13 and 9 months without treatment and giving birth to a child, one lived 3¾ years, dying at the age of 75 of "old age," and one lived 7½ years, dying at the age of 83 of "old age."

Of the 4 operable cases, one had lived 4 years, one for 3½ years and 2 for 2 years. Grouping his cases according to the thoroughness of their treatment, he reports that only 6 cases were treated as completely as desired, and that of these 5 were cured, the one who died surviving 10 months to die during an operation done because of an

attack of asphyxia. In his sixth cured case he gives all credit to the operation, which was a complete removal, only one series of röntgen treatments having been given. He recommends prophylactic raying of the regional and hilal lymph-nodes, and in this point is in disagreement with Jüngling,[29] who fears the deleterious systemic effects of such radiation of areas not yet demonstrably involved.

Jüngling cites the case of a woman of 73 who had a long-standing goitre which had been rapidly growing for 3 months. It was nodular, firm and fixed, the circumference of the neck being 50.5 cm. Using four converging fields for röntgen treatments, to obtain 100 per cent. depth dose, he found that after 7 weeks the tumor disappeared. However, 3 weeks later a metastasis to the left hip caused her death. He cites another case, a woman of 43, who had a goitre 1½ years, with recent hoarseness and dyspnœa, presenting a nodule the size of an apple on the right side of her neck. After giving two doses two months apart (63 to 70 per cent. depth dose) she became clinically healed. He states that many operations intended to be radical must perforce be left incomplete, but that nevertheless such cases still offer good prospects with post-operative radiation, and that this fact led Perthes to recommend that in doubtfully operable cases as much as possible be removed by operation and the site be radiated afterward. He warns of the danger of early œdema of the larynx following radiation, when compression is exerted by large inoperable tumors, and advises against treating the patients as ambulatory cases. He agrees with Schaedel's recommendation that tracheotomy be not attempted when asphyxia threatens. Schaedel feels that tracheotomy in most such cases is ineffective, because the compressed place is usually too deeply situated, and even when the site of compression is above the sternum, the tumor must first be cut through. Schaedel recommends incision down to the tumor and "unfolding" the trachea by exerting traction upon the masses encircling it, thus quickly permitting restoration of respiration, then freeing the trachea from the encircling masses by resection of the middle and lateral parts of the gland, followed by primary closure.

Sudeck thinks that more extended observation will be required to determine whether there is a difference between the various types of malignant tumor of the thyroid in their reaction to röntgen therapy, but at present he is of the opinion that they are all especially favorable for this form of treatment, while for surgery they form a very unsatisfactory chapter. He advises radiation, therefore, in all cases, with no attempt at surgery. Of six of his cases, one of "sarcocarcinoma" appeared to have a lasting cure, 3 of carcinoma of alveolar structure were locally healed, but died of metastases, while of 2 cases not proven by section and who were still under treatment, one had shown rapid and one a slow regression.

Perthes' opinion in favor of radiation is based not only upon his own rich experience, but also upon answers which he had obtained from all German and Austrian surgeons to whom he had sent questionnaires. (Holzknecht.[28])

Holfelder[28] finds that thyroid carcinoma is sharply at variance with other surgical carcinomas in its radiosensitiveness, and offers an absolutely good prognosis, provided a correct technic of radiation is carried out. In 3 cases, despite incomplete operative removal, a certain and complete lasting cure had been obtained with röntgen therapy.

Werner[35] recommends röntgen treatment for the diffuse forms; radium for circumscribed forms, or for tumors in which several distinct nodules exist. He was undecided at the time of his report (1923) whether the interstitial method of radium application offered distinct advantages over the external radiation. Regression, he finds, is not rapid, in the majority of cases, but takes place within a few weeks, and there may be complete disappearance of the tumor. He states that even when the tumor is substernal, with distinct tracheal compression, a result is possible. As to the duration of the results in general, he claims cures of 3 to 4 years' standing. He warns against using large doses at a sitting, stating that rapid resorption of the thyroid tissue of the tumor may lead to severe thyrotoxic symptoms. He considers that danger of cachexia strumipriva also exists.

Klose and Hellwig think that as long as a malignant goitre is operable, an operation should be done, and that while the goal should be total extirpation of the thyroid (contrast Perthes' views), if it is possible to carry out proper post-operative radiation one may be content with a less nearly complete operation. They state that those who rely chiefly on the surgical treatment remove the primary tumor, even in the presence of metastases (von Eiselsberg, Ehrhardt and Kocher are said to take the same stand). They point out that recently a movement in favor of the radiation treatment of malignant goitre has begun, similar to the movement with respect to uterine carcinoma. While all their cases who had only the operation died within a year, the two remaining cases who went 3 to 4 years free from local recurrence and in the best state of general health had an operation that was undoubtedly incomplete, but was followed by röntgen-ray treatment with a technic assuring a homogeneous distribution of 90 per cent. of the skin erythema dose throughout the tumor. It is their view that carcinoma of the thyroid belongs in that group of carcinoma which responds with remarkable regularity to the lowermost limit (85 to 90 per cent.) of the skin erythema dose. This point is especially important, they feel, because the part of the tumor which cannot be removed by an operation is next to the trachea, and with an exact and homogeneous dose of radiation within the above limits the trachea need not be injured. Their technic consists of using Holfelder's Felderwähler, applying the radiation to two fields obliquely from the right and left to the outstretched neck in such a way that the central beams cross close behind the trachea at an angle of 140 to 150°. The distance from target to skin is 70 cm., the filtration 0.5 mm. zinc, and the voltage is equivalent to a spark gap of 30 cm. This dose is repeated after 3 months and again after a further interval of 6 months.

Weber[16] reports one case rejected elsewhere as inoperable carcinoma of the thyroid, presenting marked dyspnœa, who received 3 skin erythema doses, using 3 mm. of aluminum filter, apparently in divided doses. Within 8 days regression occurred, and dyspnœa subsided. No deleterious results were seen, and in 3 months the patient was in complete health, the circumference of the neck having been reduced from 38½ to 34 cm.

A remarkable case is reported by Estor, Rocca and Parès.[17] A woman of 45, who had first been operated on 12 years before for a benign tumor of the thyroid, and again 5 years before, presented a mass the size of a fist on the right side of her neck and extending retrosternally. Intense dyspnœa, cough and dysphagia were present. Biopsy showed a typical epithelioma of the thyroid. By the use of tubes and needles containing radium they secured a survival for 3 years in this patient, who to all appearances was rapidly progressing to a fatal outcome. They did not secure complete regression, and they account for their failure to do so in part by the substernal prolongation of the tumor, and the proximity of the carotids, which contra-indicated heavier treatment. Asphyxia disappeared in 24 hours after the use of the tubes, and in 3 days after the use of the needles.

Pfahler[10] records 10 cases treated by röntgen-ray and radium. He concludes that prompt post-operative röntgen therapy should be used, that if a diagnosis of carcinoma can be made without operation, a reasonably good hope of success can be offered by radiation, that recurrences can be made to disappear, but that definite metastases are not likely to be controlled in late cases, and advises radium for a definitely localized tumor or when the tumor ceases to respond to röntgen-ray.

Crile[12] describes one case with an advanced carcinoma, in which a decompression operation was done, followed by röntgen treatment. Within 5 months the tumor regressed so much that it could no longer be palpated, and the patient had complete relief from choking spells and local discomfort.

Heyerdahl[24] reports that of 8 cases of malignant goitre treated with radium (applied both externally and internally to the tumor in tubes), 5 were temporarily improved, but that in 3 no good effect was seen.

McWilliams[28] cites the case of a girl of 18 with a tumor of 3 years' duration, operated on twice, complete removal being accomplished the second time. This was

followed by röntgen treatment, and the patient had remained well 2½ years at the time of his report.

Balfour states that when a clinical diagnosis of carcinoma of the thyroid can be made, as a rule it is much better to advise radiation, and that the operation for the relief of pressure often has dubious results.

According to Herbst, radium or röntgen-ray or both are now routinely used at the Mayo Clinic in conjunction with surgery in all operable malignant thyroid tumors, and in certain inoperable cases. Radium, he states, has not been used long enough in their experience, so that accurate deductions as to its value can be made. Boothby states that in the cases in which carcinoma is recognized too late for complete surgical removal, radium and röntgen-ray have been found of value in checking the progress of the malignancy and in prolonging life.

A. Kocher, despite his assertion that the paucity of literature on the radiation treatment indicates that the results have not been worth publishing, admits in the same article that it is his rule to give radiation after every operation on a malignant goitre, also to every inoperable case. He considers it dangerous to make such assertions as those of Sudeck and Schaedel regarding the peculiar radiosensitiveness of struma maligna, for fear that it may lead to withholding from operation many cases that could be cured by surgery. He does admit that radiation seems to have a good effect on certain cases, and delays recurrences and metastases.

Crotti in the 1918 edition of his book classed treatment by radiation along with tracheotomy as an important palliative form of treatment.

Beck,[3] in a recent report from the Kiel Surgical Clinic, states that he has been unable to confirm the absolutely good prognosis claimed by Holfelder, Schaedel and others, nevertheless regards the results of radiation as very gratifying. Of seven cases three went for periods of 4, 3 and 2 years completely free from evidence of disease, the fourth case had a recurrence in the submental region which did not regress with röntgen treatment, but had not increased in size for 9 months, another case regained the use of his voice, which had been lost as a result of recurrent paralysis, and two cases responded only temporarily.

MEMORIAL HOSPITAL RESULTS

An investigation of cases of cancer of the thyroid treated at the Memorial Hospital in recent years was suggested by the casual observation that a number of cases had accumulated who, having been referred here for post-operative radiation, had remained well for periods of two to four years and longer. It seemed desirable to inquire more closely into the history and treatment of these cases, and to compare their course with that of the cases that had not done so well, in order to ascertain whether any facts might thus be brought to light which could have any bearing on prognosis or treatment. Another matter for inquiry was the question of the probability of malignant changes occurring in adenomas. The literature bearing on this point has been reviewed in part in the preceding portion of this paper. Marine and Kimball, in advocating the use of iodin to prevent the appearance of goitre, a procedure which is gaining wide acceptance to-day, have implied that by thus preventing the development of adenomas, carcinoma of the thyroid would be largely prevented, for, they state, "probably 90 per cent. of the malignant tumors of the thyroid arise from these adenomas."[26] Thirty-three cases of cancer of the thyroid were available for this analysis. (Twelve others were excluded only because of lack of sufficient data.)

Pathological reports were available in 19, as follows: Adenocarcinoma in 12, carcinoma in 3, diffuse round-cell carcinoma in 1, metastatic thyroid adenocarcinoma in the ilium in 1, "round-cell sarcoma" in 1, and "small spindle-cell fibrosarcoma" in 1. The last two named probably should have been designated as carcinoma.

Of the 33 cases, 10 are now living, 19 are dead, and 4 were lost track of (after 6 months, 9 months, 3 years and 3 years, respectively).

Of the 10 living cases, 7 show no evidence of disease at the present time. The shortest period of freedom from recurrence in this group is 2 years and 2 months; the longest, 7 years and 11 months; and 6 cases have remained free from evidence of the disease for over 3 years.

It is a rather striking fact that of the 10 cases now alive, 9 had an operative removal of the tumor done from 2 weeks to 3 months before coming to this hospital (except one case, who was operated on by Doctor Quick 2 weeks after admission); and in 7 of these, as far as one can judge from the records, the operation was apparently a complete removal of all the gross tumor. It is also noteworthy that of these 7 cases in which an apparently complete removal of the tumor was accomplished before radiation was begun, all but one belong now to the group free from evidence of disease; and that the other case of the 7 who are now free from evidence of disease also had an operation which was, however, apparently incomplete.

Of the 10 living cases, the 3 which are not free from evidence of disease, have all shown definite improvement following radiation. One had an apparently incomplete operation, one an apparently complete removal, and the other was not operated on. The one who had the apparently complete operation improved and remained free from evidence of the disease for two years, and then developed a pea-sized recurrence attached to the anterior edge of the sternomastoid. This is now under treatment, and is showing very satisfactory regression.

No fixed conclusions can be drawn from a study of only 33 cases of such a variable disease as cancer of the thyroid; nevertheless, it has been of interest, and perhaps of some significance, to compare the foregoing living cases with those who died. Here we find that of the 19, while one lived over 6 years after first coming to this hospital, dying of cancer of the stomach, and one lived 5½ years to die of cancer of the breast, 5 showed only temporary improvement, 11 were unimproved, and one was perhaps made worse by the treatment. There is no such striking coincidence as in the living cases between cases operated on and cases improved, for we find that of the 5 cases operated on with a complete removal of the tumor 3 weeks to 10 months before coming to this hospital (excluding another case who had been operated on 9 years before), 2 were temporarily improved, 2 were unimproved, and 1 was perhaps made worse by treatment here. Two cases had what was known to be an incomplete operation. In one, this was done for a supposed colloid goitre 2 months before the patient entered this hospital. The pathological report was "round-cell sarcoma." Following radiation the thy-

roid region became and remained free from evidence of disease for 5½ years, but after 4 years a breast tumor developed which at first responded to radiation, but later infiltrated the entire breast. Sections from the breast tumor showed "small foci of small cells," and it remained uncertain whether it was a primary breast tumor or a metastasis from the thyroid. She also had evidence at that time suggesting lung metastasis. Another case had an operation elsewhere one month before coming to this hospital. The operation was apparently incomplete. An excision of the right lobe had been done, but the operation was followed immediately by an increase in the size of the goitre. However, after two years she became free from evidence of disease locally, and lived for 6 years, dying then of cancer of the stomach, apparently an independent tumor.

Of the 19 cases now dead, 11 never were operated on. Three of these showed temporary improvement, and 8 were unimproved.

The following table summarizes the outcome in all the cases, separating the cases operated on from those not operated on:

Number of cases	Operation	No evid. of disease to date, or when lost track of, or at death			Improved			Unimproved			Made worse	No information
		Living	Lost track of	Dead	Living	Lost track of	Dead	Living	Lost track of	Dead	Dead	Lost track of
16	Complete	6	2	..	1	..	2	..	..	3	1	1
4	Incomplete	1	..	2	1	..	..	..	..	[illegible]	..	..
13	None	..	..	..	1	1	3	..	..	8	..	..
33	Total	7	2	2	3	1	5	..	..	11	1	1

The methods of treatment used have varied a great deal, depending upon the indications of the individual case, and also, because of changes in technic as new methods have developed. In general, in the group treated "prophylactically" following removal of the tumor, external radiation with either röntgen-ray or the radium pack has been used. With röntgen-ray the technic has of course changed greatly in the past few years. Whereas formerly a long series of small doses of comparatively feeble penetrating power was employed, the shift in recent years has been toward the use of fewer doses of more intensive shorter wave-length therapy. When definite recurrences have developed, or in those cases that had not been operated on, in many instances the implantation of bare capillary glass tubes containing emanation, or the insertion of needles containing radium element or emanation directly into the tumor was practised.

The less favorable anatomical relations of several of the cases that did not survive is reflected by the number of other procedures that were found necessary as attempts to prolong life; namely, tracheotomy in 3 cases, with immediate fatality in 2, and gastrostomy in 2 cases.

Most of the deaths occurred at home or in other institutions, so that the exact mode of death of several cases does not appear on our records.

The most common terminal symptoms noted are dyspnœa and cough, due to either lung metastases, or compression or infiltration of the trachea, or both. Two cases died in acute asphyxia following unsuccessful attempts at tracheotomy. Infection and hemorrhage proved fatal in one case. Two had marked dysphagia. Others showed chiefly weakness and cachexia.

As regards metastases, positive evidence was found in a surprisingly small number. Of the living cases there are only one certain and two questionable instances of metastases to cervical nodes, and no definite evidence in any of lung or bone metastases. Of the dead cases, 3 showed metastases to cervical nodes, 5 to the lungs, and one to the ilium, while 2 had questionable lung involvement, and one had a breast tumor which may or may not have been secondary to the thyroid tumor.

It is interesting to note that the average age of the cases that are now living was 12 years less than that of the dead cases (44.3 *vs.* 56.3 years). The age limits of the living cases were from 20 to 67, while those of the dead cases were 32 to 78.

The living cases on the average appear to have come here much earlier in the course of their disease. Counting the first appearance of a lump in the thyroid as the beginning of the disease, the living cases, *on the average*, had symptoms for 5 years and 7.4 months; the dead cases, 7 years and 9.7 months. The long average duration in the dead cases, however, is raised chiefly by 3 cases of 25, 35 and 43 years' duration.

These long durations may seem to support the statement of Marine, Kimball and others that a large percentage of thyroid carcinomas develop in long-existing adenomas, and to argue for the iodin treatment, especially in endemic goitre districts to prevent the appearance of such tumors (if that is possible), and for the early eradication of all such tumors as a part of the preventive treatment of precancerous conditions.

On the average the living cases have survived nearly three times as long as the dead cases after coming to this hospital (3 years, 10.4 months and 1 year, 4.8 months, respectively).

SUMMARY

1. Varying reports in the recent literature of the treatment of cancer of the thyroid and some interesting points brought out in a study of 33 cases at the Memorial Hospital, justified a partial review of the literature in order to bring together and emphasize some of the more remarkable features of this disease and the conflicting statements of various writers on the subject.

2. The interpretation of thyroid tumors requires special standards not applicable elsewhere. Malignant qualities of a thyroid tumor must be judged from the clinical and gross anatomical features, rather than from the microscopical aspect.

3. Probably all malignant tumors of true thyroid origin are epithelial; the occurrence of true sarcoma of the thyroid in man is doubtful.

4. Carcinoma of the thyroid is frequently, and perhaps with few exceptions, preceded by previous goitre.

5. Some observers find that carcinoma of the thyroid begins almost exclusively in the right lower pole.

6. There is a very acute form of cancer of the thyroid.

7. Various infections, irritants, traumata, circulatory disturbances, etc., have been assigned etiological rôles by different observers.

8. Cancer of the thyroid is most common between the ages of 40 and 60, but has been seen in very young children.

9. One to five per cent. of all goitres operated on are malignant, according to different observers.

10. Cancer of the thyroid is very rare in true exophthalmic goitre, but may occur in that condition.

11. Thyrotoxic symptoms, on the other hand, are common, and in certain clinics are regarded as a very important initial sign of malignant change in a goitre.

12. Females have cancer of the thyroid about twice as frequently as males.

13. Kocher's clinical distinctions between various forms of malignant thyroid tumors are given in part.

14. There are no characteristic early symptoms of cancer of the thyroid.

15. The differentiation from solid adenomas and from chronic strumitis of the Riedel type is most difficult clinically.

16. Fixation should be determined by the degree of mobility of the tumor *with reference to* the trachea or other apposed structures, and not by its ability to move up and down *accompanying* the trachea during the act of deglutition.

17. Metastases are common; their route of dissemination is unusually frequently by the blood stream; and bone metastases may show either osteoplastic or osteoclastic properties.

18. When a clinical diagnosis of cancer of the thyroid can be made, it usually means that the disease has progressed so far that cure by surgery is impossible, and in fact, the case may be made worse by operation.

19. The mortality from operations for cancer of the thyroid is very high.

20. Leading German radiologists agree that carcinoma of the thyroid is remarkably radiosensitive.

21. Reports by surgeons and radiologists on the treatment of cancer of the thyroid in the recent literature are given.

22. A report is made on 33 cases of thyroid cancer that have been treated at the Memorial Hospital.

23. Ten cases are now living, 7 free from evidence of tumor for from 2 years and 3 months to 7 years and 11 months. The other 3 living cases show definite improvement.

24. The living cases were 12 years younger, on the average, when their treatment at Memorial Hospital was begun, than those who died; and already they have lived three times as long after coming to the hospital than did those who died.

25. On the basis of this study it would seem best to advise early complete removal of all nodular tumors of the thyroid. While this procedure does not

guarantee that other similar tumors will not appear later in the remaining portions of the gland, it will discover many unsuspected carcinomas. If carcinoma is so discovered, prompt and thorough post-operative radiation with röntgen-ray or the radium pack should be used. If a clinical diagnosis of cancer of the thyroid can be made, operation should be avoided, and thorough radiation, either by heavy röntgen-ray or external radium applications, or these combined with an efficient form of interstitial radium application should be carried out.

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CONGENITAL CYSTS AND FISTULÆ OF THE NECK

A REVIEW OF 42 THYROGLOSSAL CYSTS AND FISTULÆ

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Congenital cysts and fistulæ occurring in the cervical region have always excited interest. Their intricate and elaborate embryology and diverse pathological histology have aroused much speculation. A thorough knowledge of their anatomical relationships is of great importance in securing a complete extirpation, which alone insures a cure. Recently renewed interest in this subject has been manifested, and many excellent papers have appeared, notably those of Thompson,[1] Christopher,[2] Sistrunk,[3] Bertwistle and Frazer,[4] and Bailey.[5] However, there still seems to be considerable confusion as to the origin of the embryological rests occasioning these congenital abnormalities. Much which Kostanecki and Milecki,[6] His,[7] Hammar,[8] and other embryologists have stated still remains unchallenged, but many of their interpretations and deductions have been justly questioned by the more recent investigations and excellent reconstructions of Wenglowski.[9]

It has been the custom of most surgeons to classify arbitrarily those cervical abnormalities occurring in the midline of the neck as originating from the remnants of the thyroglossal tract, while those which appear on the lateral aspect, as arising from the branchiogenetic system, with the possible exception of a small group which are indexed as hygromata.

But no proper classification of those anomalies can be made until their fundamental relationships to the structures from which they arise have been duly clarified. There are certain salient features and basal concepts which are of prime importance in making a proper diagnosis, for upon this will depend the plan and extent of the surgical procedure. Using the excellent paper of Wenglowski [9] as a guide, the various congenital cervical cysts and fistulæ, admitted to the surgical wards of the Mount Sinai Hospital, New York, 1913–1924, have been reviewed in the hope that a closer scrutiny of the embryology, pathology, and clinical features might place the diagnosis and treatment on a more rational basis.

The embryology of the lower jaw and neck region will be briefly summarized because it plays such an important rôle in the diagnosis, and in the surgical approach to these congenital abnormalities.

In the human embryo of 2.6 mm. the first two branchial arches are quite clearly developed, the former bounding the primitive mouth, the latter placed just above the heart. Three or four other arches are developed subsequently, separated by the same number of branchial grooves. The ultimate fate of the

gill arches is well known; the first give origin to the side portion of the upper lip, the upper jaw, the lower jaw, and the body of the tongue. The second forms the body of the hyoid bone, its lateral attachments, and those muscles and ligaments which are attached to the styloid process, in addition to the anterior part of the root of the tongue and the palatoglossal arch. The third develops the greater horns of the hyoid, the posterior part of the root of the tongue, the palatopharyngeal arch and its muscles. The fourth, fifth, and sixth arches take their part in the development of the soft parts in the region of the horns of the hyoid. The branchial grooves which are found between these arches are dependent upon the growth of the latter. The mesial ends of the gill arches and furrows run anteriorly and orally, while the pharyngeal arches and pouches run below and aborally. From this it is apparent that the floor of the branchial depressions and the corresponding pharyngeal pouches run in different directions and lie upon one another only in one small area and even here there is a very definite partition separating these two structures. This is an important point, for it immediately becomes evident that the gill furrows are never open and can never communicate with the pharynx. The disappearance of the branchial furrows which occurs at the end of the second month is brought about by two forces: first by the ingrowth of mesenchymal tissue; and second, by the rapid growth of the branchial arches which approximate each other more and more, thus narrowing the furrows which finally disappear. And, with the disappearance of these furrows, the cervical sinus which His[7] incorrectly held responsible for the development of the thymus, and as coming from the second arch, also vanishes by the amalgamation of the under surface of the third arch with the projection of the lateral cervical fold. This is so complete that microscopic examination of sections of older embryos discloses the cervical sinus or its rests as vesicles of stratified epithelium embedded in mesenchymal tissue. It should also be remembered that some of the strands of epithelial tissue lying free in the mesenchyme undoubtedly become pinched off from the gill furrows, because the arches and the grooves are both covered with stratified epithelium. The pharyngeal pouches, too, are covered with stratified epithelium, but the third and fourth from which the thymus and thyroid arise, may be covered with islands of ciliated epithelium. From this short description the entire branchiogenetic system and its possible rests are limited, and must be limited to an area bounded above by the lower jaw, and below by the hyoid with its processes, and any congenital anomaly occurring below this boundary cannot possibly be considered as branchial in origin. In addition, the branchial grooves remain for such a short time and are filled out so rapidly that it is difficult to conceive a perforation from the gill cleft beyond the second month.

So, cysts and sinuses occurring along the mesial border of the sternomastoid muscle, ranging from the hyoid bone to the suprasternal notch must be accounted for in some other way, and the reconstructions of Wenglowski[9] make it fairly evident that these vestigial remains are intimately connected with the development of the thymicopharyngeal duct. The anlage of the

thymus is first noted in a 6.5 mm. embryo as a small outgrowth from the third pharyngeal pouch, and while it unquestionably comes into contact with the epithelium of the cervical sinus, it is not a part of it. At first the thymic canal is horizontal, running from the lateral pharyngeal wall between the third and fourth arches, but it soon bends at right angles, crosses mesially and anteriorly and then runs downward, lying lateral to the upper part of the thyroid gland, its lower thickened end gradually sinking beneath the lateral thyroid anlage. The lower end of the thymic canal which is quite thick and without a lumen is lined with stratified, pavement epithelium, and here and there with ciliated cells. In a 16 mm. embryo the lower end appears as a fully developed gland, and this finally sinks into the superior mediastinum anterior to the great vessels. As this occurs, the upper portion of the canal begins to retrogress. The direction of both thymic canals is essentially the same, running from the palatopharyngeal area sharply across the space between the ear and the angle of the jaw, hence mesially and ventrally along the dorsolateral boundary of the thyroid and the mesial border of the sternomastoid muscle to the sternum below where both canals almost meet in the substance of the thymus. In an embryo, varying in age from two to three months, it is unusual to find thymic rests in the region of the pharynx, but these are quite common dorsal to the lateral lobes of the thyroid and especially below. Their structure is fairly typical, a centre of varying diameter, lined with ciliated or stratified epithelium; the nearer the rest is to the pharynx, the more is ciliated epithelium apt to be present, and the nearer the rest is to the sternum, the more is stratified epithelium likely to be present. It is fairly common to have both in combination. Beyond the lining epithelium there is a heavy layer of epithelial cells and epithelioid cells resembling lymphoid cells. While these may exist in embryos from three to four months, they may remain latent throughout life, their fate being quite similar to those rests of the median thyroid anlage.

The development of the thyroid gland is not very complicated. In an embryo of 2.6 mm. the median anlage of the thyroid is present as a small depression of mouth epithelium whose direction is anterior and in front of the heart and aortic region. Later this cylindrical epithelium grows into the depths as a firm hard strand of tissue without a lumen, then the lower part of the anlage begins to grow rapidly into two segments, a right and a left, while the upper part eventually disappears, or may remain as a permanent strand, occasionally giving origin to the lingual thyroid. At the end of the fourth and beginning of the fifth week the simple process of the development of the middle lobe of the thyroid is complicated by the development of the hyoid bone, and since this structure bears such an important relationship to the radical cure of some thyroglossal fistulæ, the details of the development will be discussed later.

At the end of the second month the origin of the median anlage of the thyroid is a blind opening, the foramen cæcum covered with stratified epithelium, with an occasional ciliated cell. The lingual duct which develops about

this time is not a rest of the tractus thyroglossus, but rather a canal of mouth epithelium. In the third month the lingual canal has definite side branches, and these are lined with stratified and ciliated cells. In the fourth month it is branched so definitely that individual sprouts may change into isolated cysts which may later become pathologic. These cysts may also derive their epithelial building blocks from another source, namely, from those portions of the mouth epithelium which have mechanically been pulled down by the rapid downgrowth of the median thyroid anlage into the underlying mesenchymal tissue. Very often about these mucous cysts of the tongue small isolated areas of thyroid tissue may be present. These cysts occur, as a rule, at the root of the tongue or about the hyoid, less frequently near the foramen cæcum, more rarely near the isthmus of the thyroid.

The hyoid bone makes its appearance at about the fourth week in the region of the second arch, lying behind the thyroglossal tract, which, if it remains, may be bound to the periosteum of the hyoid on its inner aspect. For the next few weeks, in spite of this relationship, the thyroglossal tract lies in a more or less straight line. But as the body of the hyoid now grows behind and above, and at the same time in front and below, the tractus thyroglossus undergoes many complicated and important changes, dependent upon the further development of the hyoid bone.

The front and lower part of the hyoid presses the thyroglossal tract anteriorly and bends it, and in this way the tract is divided into two parts, the higher portion lying anterior to the hyoid and the lower portion going from its under end. At the beginning of the third month the hyoid changes materially, the anterior surface becomes convex, and the posterior concave, with the result that the lower strand is pushed more posteriorly. The hyoid is bent now almost at right angles and may give evidence of thyroglossal remains in three places—on the upper anterior surface, on the lower anterior surface, and on the posterior surface. In other embryos and in cadavers it is rather rare to find thyroid rests on either the upper or lower anterior surface, because these two areas of the hyoid exert the greatest pressure on the thyroglossal tract, usually causing its obliteration, while the rests on the posterior surface are more apt to remain undisturbed. Thyroid rests in the neighborhood of the hyoid bone are often found in adult and children cadavers, and these may occur simultaneously with cysts of the tongue.

The lateral lobes of the thyroid are developed from the fourth pharyngeal pouches as wide pockets lined with stratified epithelium. These gradually sink deeper and become more anterior, finally blending with the median lobe as the original canal disappears. Remains of thyroid tissue may be found between the lateral pharyngeal wall and the thyroid cartilages, but the lateral thyroid canal usually disappears completely and rarely gives rise to any rests. More often, portions of thyroid tissue may be pulled off the thyroid itself, and these particles lead to abnormally located thyroids, dorsal to the œsophagus, or between it and the trachea.

The difference between lateral and median fistulæ, as far as their his-

tology is concerned, is quite a marked one. While the median fistulæ are built from epithelial rests derived indirectly from the median thyroid anlage and never possess an actual lumen, the lateral cervical fistulæ are derived from the remains of the thymic canal itself either in part or entirely. The presence of lymphoid tissue in appreciable amounts is another proof of their thymic origin. While the median anlage of the thyroid leaves behind the foramen cæcum, it never forms a complete median fistula, while the thymic anlage may form a complete lateral fistula. Lateral fistulæ and cysts are lined, as a rule, with stratified epithelium with endothelial characteristics—without hair, papillæ, sweat or sebaceous glands. Occasionally lying between the epithelium, one may find ciliated cells, the ciliated epithelium being of the same variety as in the median fistulæ. However, the presence of epidermoid tumor or fistula with all its characteristics occurring in the lateral region of the neck, does not speak against its origin as a lateral cervical cyst or fistula, for the thymic canal as it rounds the corner previously described may take with it epidermal epithelium from two sources. The cervical sinus, which itself may form a primary cyst very similar to a dermoid, may give some cells to the thymic canal, but there is still another way in which epidermal tissue may take part in the development of the thymus. It is perfectly possible for the deeper layers of epithelium from the third furrow to climb into the thymic anlage. This epithelium may keep its characteristics and not only aid in building Hassel's corpuscles, but also invest the thymic canal with structures of epidermoid character. This classification is thoroughly satisfactory in elucidating the histopathology of those cysts and fistulæ in which epidermal and endodermal tissues manifest themselves.

Incidence.—There were in all forty-two cases of thyroglossal cysts and fistulæ. These we have divided into thyroglossal cysts of which there were thirteen; thyroglossal fistulæ, twenty; a combination of cysts and fistula, nine. During this ten-year interval a summary of the record shows that in all, sixteen cases have been classified as branchiogenetic cysts or fistulæ. In view of the somewhat meagre operative notes in some of these latter cases, it seems hardly justifiable to record these cases as of branchial origin; while in others, the operative findings supply ample proof that the diagnosis under which the patient was finally discharged from the hospital was untenable in the light of more recent embryological research. For this reason no detailed summary of this group of cases has been deemed advisable.

Age.—In this series, cases occurred from the first to the sixth decades, and were grouped as follows: from the first to the tenth year, twenty-one; from the eleventh to the twentieth year, ten; from the twenty-first to the thirtieth, seven; from the thirty-first to the fortieth, two; from the forty-first to the fiftieth, one; and from the fifty-first to the sixtieth, one. In five cases the lesion was present at birth; in two a cyst presented; in three a fistula was noted. In two cases symptoms were noted during the first year of life. The oldest age at which the lesion was first discovered in this series was thirty-five and thirty-nine years of age, respectively.

Sex.—It has been variously stated that this group of congenital affections was more common in females, corresponding to the greater incidence of thyroid disease of adult life, but this has not been borne out in this series. There were thirty-one males as opposed to only eleven females.

Location.—Thyroglossal cysts and fistulæ may occur anywhere along the course of the thyroglossal tract, *viz.*, from the foramen cæcum to the body of the thyroid gland. For purposes of description these locations have been tabulated as follows:

1. Beneath the foramen cæcum.
2. In the floor of the mouth protruding beneath the chin.
3. Suprahyoid.
4. Subhyoid.
5. On the thyroid cartilage or membrane.
6. At the level of the cricoid.
7. In the suprasternal notch.

The first three of these situations have been found extremely rare; in this series no cases have been observed here. The great rarity of the occurrence of thyroglossal cysts and fistulæ in this location must make one scrutinize very closely those cases which have crept into the literature under this heading, as possibly being dermoid cysts of the tongue,[10] ranulæ, or cysts having their inception in the lingual duct and not, as supposed, originating in the anlage of the thyroglossal tract. One case presented itself in the suprahyoid region, and seven in the prehyoid region. In the presence of a cyst of any considerable size, it is sometimes extremely difficult to determine its exact location in relation to the thyroid cartilage and thyrohyoid membrane, for very frequently the swelling will overlap both structures, but in spite of this fact, we have classified twenty cases as thyrohyoid and three as cricoid. Three, also, presented themselves in the suprasternal notch. It has been almost universally taught that thyroglossal cysts and fistulæ present exactly in the median line of the neck, somewhere along the course of the thyroglossal tract. It is important to bear in mind that this need not necessarily be the case. In six cases of this series the cyst or fistula was definitely placed either to the right or left of the median line. Just recently one of us had occasion to excise a cystic swelling on the right side of the neck at the level of the thyroid cartilage. Its position was so far lateral to the median line that a diagnosis of thyroglossal cyst was barely entertained. In spite of this fact, a prolongation of the cystic mass was found to run to the under surface of the hyoid bone exactly in the median line, and the pathological report of the excised cyst wall and tract was reported back "Thyroglossal cyst." It is well to bear in mind, however, that although the opening of the fistula or cyst may be eccentrically placed, the tract itself is almost invariably found in a median position. Whether previous operative interference or the accommodation of the tumor to the various muscle and fascial planes accounts for its shift from a previously medial to a lateral position, is merely conjectural and is simply offered as an explanation for the unusual find in some cases.

In those cases in which careful operative notes were appended to the records, it was found that the tract apparently split the hyoid bone in seven cases; in three cases it was found to run in front of the hyoid bone. No mention is made of any case in which it was clearly discernible that the tract ran behind the hyoid. In thirteen cases it was specifically stated that there was no connection between the tract and the hyoid bone, but any one who has operated a number of these cases will undoubtedly concur in the observation that when the tract reaches the region of the hyoid it becomes greatly thinned

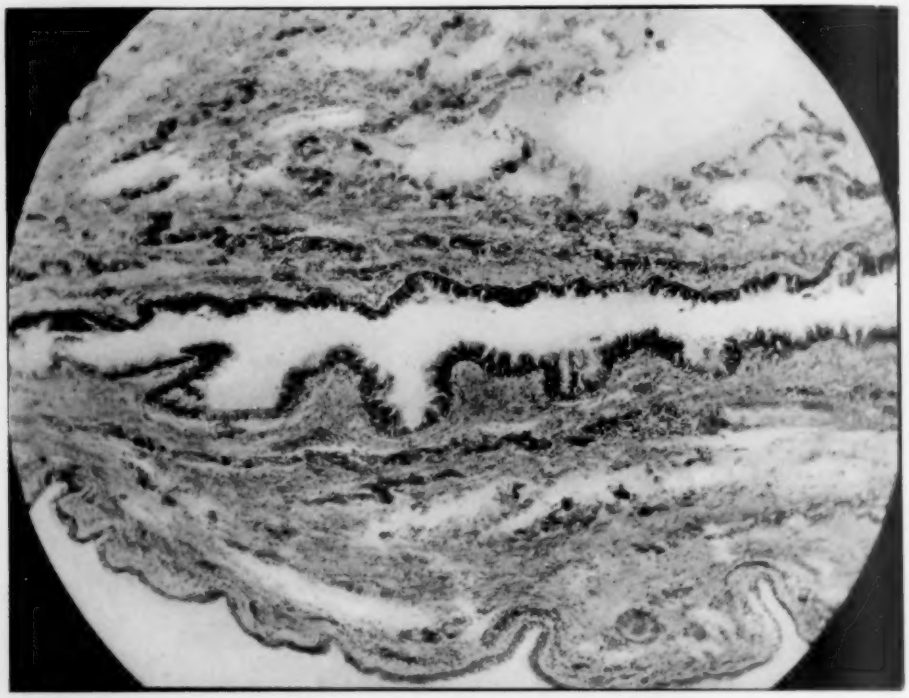

FIG. 1.—Photomicrograph showing general outline of a thyroglossal tract lined with stratified columnar epithelium.

and attenuated, at times almost indistinguishable from the surrounding fascial structures, so that to insure a complete removal, not only the tract but the surrounding tissues in the mid-portion of the hyoid must be excised *in toto* to affect a radical cure. In the light of this fact, a statement that a thyroglossal tract preserves no connection with the hyoid bone must be guarded. This point will again be alluded to in discussing operative procedure. Perhaps a more general utilization of ante-operative injection of the sinus with a medium opaque to the X-ray, as sodium bromide, would permit us to discover more accurately the relationship of the sinus to the hyoid bone with which it is usually so intimately connected. In six cases, the tract was traced upwards between the geniohyoid and the geniohyglossus muscles where it was found to terminate at the foramen cæcum.

Pathology.—In not all cases were the excised specimens submitted to the

laboratory for pathological examination. In two cases the material was reported as thyroglossal fistula or cyst; in six cases as fibrous tissue lined with epithelium. The epithelium was usually of a low cylindrical or columnar type, at times of a stratified columnar variety (Figs. 1 and 2). In two cases no epithelial lining was discernible. It is supposed that in cases in which no epithelium is found upon microscopic examination, in the presence of clinical evidence supporting a diagnosis of a thyroglossal cyst or fistula, the long continued suppuration may destroy the epithelial lining (Fig. 3). In two cases

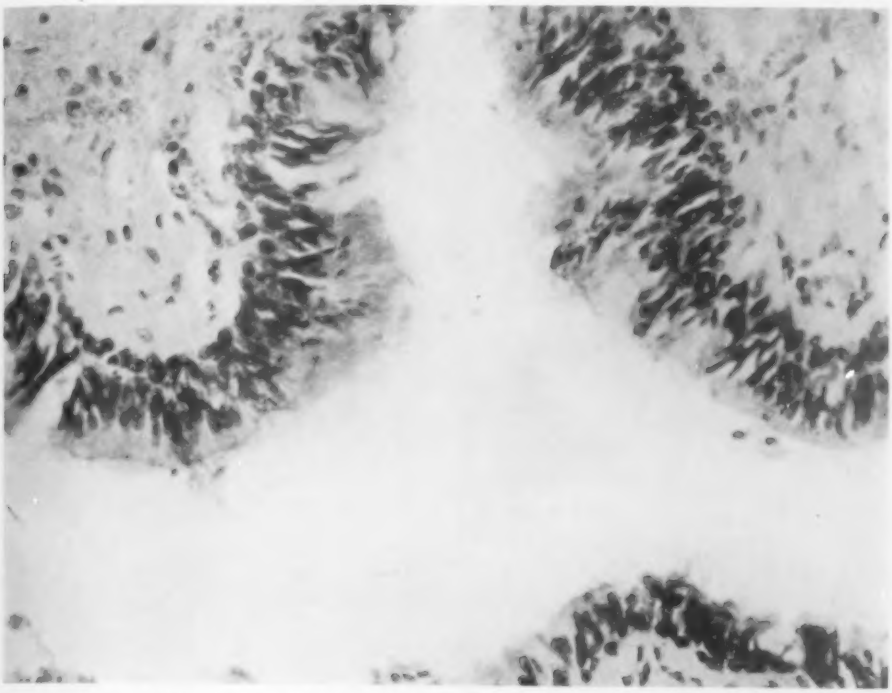

FIG. 2.—High-powered photomicrograph of a portion of the lining epithelium of Fig. 1.

large masses of lymphoid tissue surrounded the fistulous tract. In view of this finding it is barely possible that this represented remains of the thymico pharyngeal duct. Mention of this will again be made in discussing pathogenesis. In two cases definite islets of thyroid tissue were found. It has been said that the presence of thyroid tissue along the course of the thyroglossal tract stands in inverse relationship to the normal development of the thyroid gland. In both these we find no mention made of the size of the thyroid gland or any evidence pointing to endocrine dysfunction.

Pathogenesis.—Thyroglossal cysts and fistulæ usually make their first appearance in infancy and childhood; in this series twenty-one occurred before the second decade of life. To what can we adduce this high percentage? In discussing "Pathology" we noted the fact that in some cases lymphoid tissue made up the bulk of the tract wall; in others, the epithelium was destroyed as though by an inflammatory process; while in some, evidences of inflammation

were denoted by an infiltration of the tract by polymorphonuclear leucocytes or by round cell infiltration. The intimate relationship between the mouth epithelium and the original anlage of the thyroglossal tract makes it plausible that the same inflammatory processes to which the former is susceptible, particularly in childhood, accounts in some cases, at least, for a like susceptibility. With the onset of a tonsillitis or pharyngitis, to which the young are so prone, a similar reaction on the part of the lymphoid tissue in the thyroglossal tract would account for the pathogenesis in some cases. There were three cases in

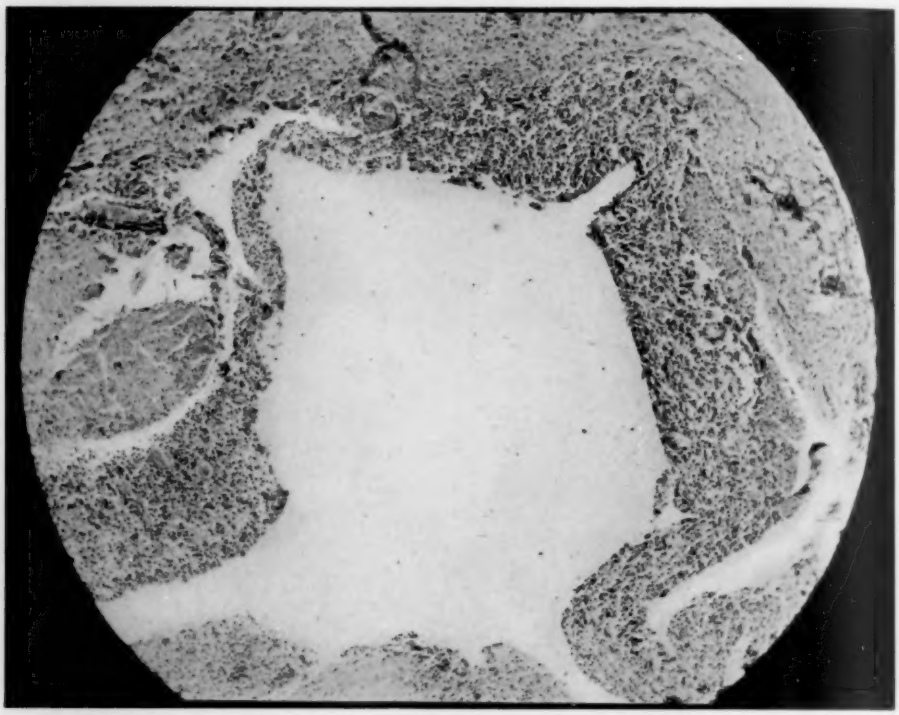

FIG. 3.—High-powered photomicrograph showing a thyroglossal sinus lined with granulation tissue.

which a history of upper respiratory infection antedated the development of the cyst. Metastatic infection of the thyroglossal tract may account for others.

The production of thyroglossal fistulæ, as opposed to cysts, is usually the result of rupture of the latter. This is borne out by the great paucity of congenital fistulæ in contradistinction to congenital cysts which are much more common. Suppuration in cysts, either spontaneous or by incision, play a part in the production of these fistulæ. Probably the most common cause is surgical intervention. No less than eighteen patients were operated upon before entering the hospital, with a fistula as the direct result of operative interference. This point will be further discussed under treatment.

Symptomatology.—It is noteworthy how few subjective symptoms the presence of this lesion produces. Pain is usually absent—in only three cases was there definite pain, and this only in association with an inflammatory proc-

ess which the cyst was undergoing and which probably brought the patient to the hospital for treatment. A tumor was present in fifteen, whereas a sinus occurred in twenty-nine. In the cases in which a discharge was a prominent symptom, it was mucus in six, purulent or muco-purulent in ten; in thirteen, the character of the discharge was not mentioned. In none was it profuse. In only one was it more profuse on swallowing. In six cases the discharge was intermittent.

Physical Findings.—These are usually fairly characteristic depending upon whether we are dealing with a cyst, fistula, or a combination of both. In the former we usually find a small, round, tense cystic mass, varying in size from a pea to a walnut, over which the skin is usually movable, except in the presence of an inflammatory process, in which case the skin may become adherent. Fluctuation is not always elicited on account of tension within the cyst wall. The location of the lesion has already been discussed. In the presence of a fistula a small, firm mass of tissue may be felt by careful palpation, running subcutaneously from the region of the fistula to the hyoid bone, where it is lost as it emerges in the substance of the latter to make an acute angle with that bone from where it penetrates the tongue musculature.

Diagnosis.—The diagnosis is at once simple and difficult. In the absence of infection, a medially situated tense cystic mass or fistula should at once suggest the diagnosis. In the presence of an inflammatory reaction, the lesion must be differentiated from an enlarged, chronically or acutely inflamed submental or prehyoid lymph-node. The presence of a dermoid cyst in the median line of the neck, while offering difficulties in diagnosis, may be correctly differentiated by aspiration.[11] Ectopic thyroid glandular tissue must be borne in mind in differentiating any mass in the neck. Tumors or masses in the floor of the mouth, particularly lingual dermoids or submental cysts (remnants of the lingual duct), or deep-seated ranulæ must be ruled out. In certain cases the opening of a lateral cervical fistula is close to the median line, particularly in those having their exit just above the clavicle, but in these cases it will be noted that the opening is situated just to the outer border of the sternocleidomastoid muscle.

Treatment.—Simple incision of a non-suppurating or suppurating thyroglossal cyst invariably leads to the formation and persistence of a fistula, which must be dealt with radically at a later date. No operative treatment that is not based upon the known relationship of the thyroglossal tract to the hyoid bone, tongue musculature, and foramen cæcum, as outlined in the portion of this article dealing with the embryology of these structures, can hope to be radical. Prior to the application of these principles, recurrences of the fistulæ were the rule rather than the exception. Numerous references in the literature bear evidence to this fact. While surgeons undoubtedly had appreciated this fact, it was not until 1919 when Beer [11] and Sistrunk [3] independently published an operative technic for the cure of these fistulæ, that the treatment was put on a rational basis. Their operative procedure takes the above-mentioned points into consideration, and will be outlined briefly.

A transverse incision (all neck incisions in so far as is possible should be transverse), circumscribing the sinus, is made, dividing the skin and platysma muscle. The skin flaps are mobilized and the tract, which usually lies superficially at this point, is dissected free from the surrounding prethyroid muscles, and is traced upwards to the hyoid bone. At this point the tract becomes thin and attenuated and no attempt is made to detach it from the hyoid. The periosteum over the hyoid is divided, and the mid-portion of the hyoid resected subperiosteally and freed. The tract is then further enucleated by coreing through the tissues between the hyoid and the foramen cæcum. It is important to bear in mind, in this connection, the angle that the tract makes with the hyoid in ending at the foramen cæcum. This will be found to be an angle of 45 degrees. With this in mind, those portions of the median raphé of the mylohyoid, the geniohyoid, and geniohyoglossus muscles, surrounding the lingual portion of the tract, are removed *in toto* up to and including the foramen cæcum. If the dissection has been started low down in the neck, a supplementary transverse incision at the level of the hyoid may become necessary. The periosteum of the hyoid is brought together with interrupted chromic sutures. The lateral portions of the divided tongue musculature are likewise united. A small rubber dam or tube is introduced for drainage purposes. This can usually be safely removed at the end of forty-eight hours. The skin is approximated with silk. If any appreciable defect be made in the mucous membrane of the tongue, this also should be united with catgut.

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COMPRESSION OF THE SPINAL CORD BY TUMOR*

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Any tumor causing symptoms of spinal cord disturbance must except in rare instances cause this disturbance by compression, whether the tumor is within or without the spinal cord. The exception being metastatic malignant disease within the cord itself causing destruction of cord tissue without compression. This condition is a rare one and I have seen it once only. If there is compression of the spinal cord there must also be a more or less complete blocking of the cerebrospinal space at the tumor level, either by a fusiform swelling of the cord, if the tumor lie within it, by the tumor itself if the tumor lie between cord and dura or by an indentation of the dura if the tumor be outside.

Fig. 1.—Lipiodol in the lumbar sac.

The recent advances in the diagnosis of cord tumor are directed in the main to a recognition of this encroachment on the cerebrospinal space and the resulting changes in the cerebrospinal fluid. There has been, and still is, a good deal of difference of opinion as to the value of this type of diagnostic procedure. This difference of opinion naturally adds to the interest of the subject and the matter will not be settled until a large number of observations have been made in early or doubtful cases. I am convinced that any procedure which will permit us to make a diagnosis of cord compression in the preparalytic stage will be of great value. It seems practically certain that careful investigation of the cerebrospinal space will many times give us the data for such a diagnosis in the absence of convincing neurological evidence.

I have attempted to group the cases of spinal cord lesion, in which tumor was thought to be the cause, which have come under my care, and the resulting figures are perhaps of some interest. In addition to the eighty-five proven cases I have included sixteen in which a negative exploratory laminectomy was performed, but have omitted all cases in which the suspicion of the presence of cord compression was not sufficient to warrant exploration.

* Read before the American Surgical Association, May 6, 1925.

As will be seen, there were nineteen cases of intramedullary tumor and the end results were almost uniformly bad. There were thirty-five cases in which the tumor arose from structures outside the cord but inside the bones of the vertebral column. Of these, twenty-six were cured or definitely and permanently improved. Tumors of the vertebral column, metastatic or primary, were twenty-eight in number and are a study in themselves. I shall not attempt to discuss them or the five cases of intraspinal tuberculous abscess which were classed as tumor suspects. There were sixteen in which no lesion was found at operation, which is far too large a number. Ninety-eight laminectomies were performed with five operative deaths.

FIG. 2.—Cap above a neurofibroma.

A further analysis of the group of extramedullary intraspinal tumors show that in this class were practically all of the successful cases. Of the thirty-five, ten were meningioma and eight neurofibroma, the rest were scattering. Twelve are symptomless, fourteen were definitely improved, many of them working. Only three have died of tumor, two of these being malignant leiomyoma metastatic from the uterus. There were two operative deaths. The average lapse of time between onset of the first symptom and operation was twenty-seven months. Earlier recognition of these cases would make for better results, as irreparable damage is almost invariably done to the spinal cord in cases where compression has been of long duration.

FIG. 3.—Same as Fig. 2, lateral view.

I am convinced that the future will bring a great change and that cord tumors will be recognized and treated at a much earlier date. Careful study of the cerebrospinal fluid in cord tumor cases is of the utmost importance and new refinements of technic are being added to the accuracy of this procedure. For a complete discussion of the subject, reference may be made to the work of Dr. J. B. Ayer.[1] Lumbar puncture should be performed in all cases of

suspected cord tumor and if there is any doubt as to the presence or absence of block, combined puncture of the cisterna magna and the lumbar space is indicated. Lumbar puncture or combined puncture in a case of this sort, or indeed in almost any case, should include careful manometric readings and study of the chemistry and cytology of the fluid as described by Ayer. Simple withdrawal of, and a more or less haphazard study of the fluid, is not sufficient. At first we were unwilling to accept these cerebrospinal fluid findings, and I therefore operated on a number of patients in spite of negative cerebrospinal fluid findings. A negative exploration almost invariably resulted. Many of these patients, either by progress of the disease or autopsy, have been shown to be sufferers from multiple sclerosis, combined system disease or other degenerative lesion of the cord itself. I am now refusing to operate on such patients. Conversely I am operating where the neurological evidence is inconclusive but where the cerebrospinal fluid shows evidence of block.

FIG. 4.—Intramedullary glioma. Note the small masses of lipiodol squeezing by the fusiform enlargement of the cord.

In cases in this series in which examination of the cerebrospinal fluid was made, lumbar puncture was conclusive in about 80 per cent. and doubtful in 20 per cent. In the 20 per cent. combined puncture was necessary to eliminate this element of doubt.

The value of cerebrospinal fluid examination in suspected tumor is no longer a matter of debate it has been conclusively proven. The only question is: How often will lumbar puncture alone be sufficient? Recent refinements in the technic of lumbar puncture as suggested by Stookey [2] may lessen the need of combined puncture, but I am sure there will always be a considerable number of cases in which it will be necessary, probably in the neighborhood of 20 per cent. We have only had two cases in which operation has failed to reveal tumor where cerebrospinal fluid examination suggested compression, and it may well be that this was due to failure on my part to

find the tumor. Only once have I found tumor where the cerebrospinal fluid findings were negative and that was some four years ago when the technic of examination was less complete than at present.

The most recent, and in many ways the most striking, advance in diagnosis of these lesions, is the use of a substance opaque to the X-ray (lipiodol) in the spinal subarachnoid space as advocated by Sicard.[3, 4, 5] After various experiments we have limited its use to cases where block is positive and always inject it above the tumor. If a positive localization can be made without the help of lipiodol I prefer not to use this drug, as it remains indefinitely in the cerebrospinal space. No permanent ill effects have been reported from its use, though it is temporarily irritating, as shown by rise in temperature, headache, and increased cell count in the cerebrospinal fluid.

FIG. 5.—Neurofibroma of cauda equina (case of Miss A. G.). Note the absence of formation of a typical cap, the tumor being buried in the cauda equina.

From one to two c.c. of the drug is injected into the spinal canal usually by puncture of the cisterna magna and with the patient in the vertical position. Its slow passage through the spinal canal is followed either by the fluoroscope or by repeated plates. During its descent the masses of lipiodol are more or less sausage-shaped and have rounded cells. When it finally comes to rest in the lower end of the lumbar sac in the absence of obstruction, it is usually in the form of an inverted cone. There may be false arrest of the lipiodol in the canal, and if such is the case, the sausage-shaped masses persist. In true arrest caused by some obstruction in the canal, the lipiodol may be seen as a cap over the tumor or as narrow streaks alongside of the obstruction.

In order to emphasize the possible value of these new diagnostic methods, one case may be cited:

Miss A. G. Referred by Dr. A. N. Broughton. This patient had had severe pain running from the lower spine down the right leg for some months. The pain was spasmodic in character and markedly increased by motion. She was unable to urinate while lying in bed, but aside from this had no symptoms which would suggest paralysis. Examination revealed a uterine fibroid and pain on any attempt to move the lower spine or the right leg. There were no paralyses, reflex changes or sensory disturbance whatever. Lumbar puncture performed by Dr. H. C. Solomon, between the twelfth dorsal and first lumbar and between the fourth and fifth lumbar vertebræ, revealed a block between these two points.

Lipiodol injected through the upper needle moved only as far as the second lumbar vertebra. Operation revealed a neurofibroma within the cauda equina so buried in the cauda that no cap could form. This growth was completely removed and now six months later she is well.

Laminectomy has been so standardized by the work of Doctor Frazier, Doctor Cushing and Doctor Elsberg that there is little more to be said, but there are a few points in technic that I would like to suggest. I have found that exposure is adequate if the dissection is carried down on one side of the spinous processes. These structures are undercut, as shown in the diagram and reflected with the ligaments and the muscles of the other side. In closing such a wound sutures in the muscles are unnecessary. A careful approximation of the fascia to the interspinous ligament is usually sufficient.

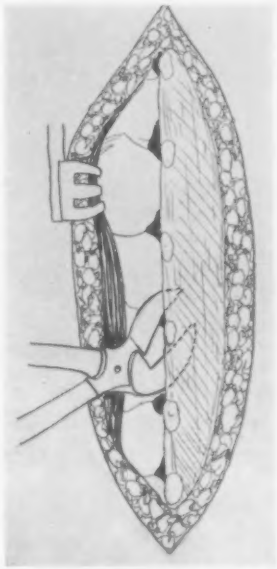

FIG. 6.—Diagram showing preservation of spinous processes.

After the laminæ have been removed, inspection will often reveal a local thinning of the epidural fat. Such a condition strongly suggests the presence of tumor. If no tumor is found on opening the dura at the level suspected, the behavior of the cerebrospinal fluid should be noted. Normally or above tumor the fluid will show a very considerable pulse wave, the pulsation being transmitted downward from the cranial cavity. If there be a tumor present blocking the spinal canal, this wave will be almost absent below the tumor. If the anæsthetist be directed to compress the jugulars for a moment, the cerebrospinal fluid will rise rapidly in the wound in the normal case, whereas the presence of a tumor at a higher level will prevent such a rise. Careful removal of the dural base of tumors, involving that membrane, should be performed where possible and any defect closed with a free transplant to prevent the leakage of cerebrospinal fluid and the resulting danger of meningitis.

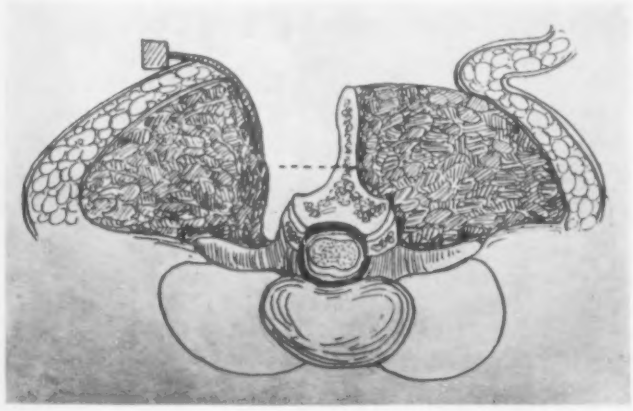

FIG. 7.—Diagram showing preservation of spinous processes. (Cross-section.)

In conclusion I would like to emphasize the fact that a very considerate percentage of tumors causing cord compression are easily and completely removable, and that if removed early enough, return of function will be complete. That early operation depends on an early diagnosis and that to this end careful and complete study of the spinal fluid is as important as is laboratory work in the study of the gastro-intestinal case.

The use of lipiodol in the spinal canal is indicated in a considerable percentage of cord tumor cases, as it is safe and accurate.

These newer procedures must in no case be expected to supercede the older methods of examination. A careful and complete neurological examination should always be performed.

TABLE I

Disease	Total	Improved	Not Improved	Improved Died later	Died
Tumors of the cord	19	2	2	12	3
Tumors of structures between cord and spine	35	26	1	3	5
Tumors of vertebra	28	2	3	4	19
Spinal tuberculosis	5	2	2	—	1
No lesions found	16	—	8	—	6*
Laminectomies	98	Operative deaths 5			

* (Two cases (untraced).

TABLE II

	Total	No Disability	Impvd.	Not impvd.	Impvd. died later of tumor	Operative deaths
Meningioma	10	4	4	1	1	—
Neurofibroma	8	6	1	1	—	—
Cholestestomatous cyst	3	—	3	—	—	—
Fibrosarcoma of cauda equina	3	—	2	—	—	1
Adamantinoma of cauda equina	2	—	1	—	—	1
Cyst of dura	1	—	1	—	—	—
Enchondroma	3	1	1	1	—	—
Malignant leiomyoma	2	—	—	—	2	—
Chronic inflammation (extradural)	2	1	—	1	—	—
Fibrosarcoma of dura	1	—	1	—	—	—
	—	—	—	—	—	—
	35	12	14	4	3	2

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ORIGIN AND DEVELOPMENT OF THE BLOOD SUPPLY OF WHOLE-THICKNESS SKIN GRAFTS

AN EXPERIMENTAL STUDY

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INTRODUCTION

There has been considerable difference of opinion as to the origin and development of the blood supply of whole-thickness grafts, and the object of this study is to determine these processes as exactly as possible. In the past, most of the observations concerning the circulation of skin-grafts have been made from the microscopic study of bits of skin excised at varying intervals after transplantation. In order to determine accurately the various phases of the development of the circulation, injections of the newly formed vessels must be made. As this is obviously impossible in the human, it has been necessary to resort to animal experimentation.

In this study, three points have been under consideration. First, whether an anastomosis is formed between the vessels of the graft and those of the grafted area; second, whether or not the capillaries of the grafted area grow into the graft by extending into the old vessels of the graft; third, whether the capillary up-growth from the grafted area penetrates the connective tissue of the graft and thus establishes a blood supply. Much theorization concerning these processes is found in the literature of the past thirty-five years, but little evidence has been brought forward to support them.

Garre, who was the first to do careful histological work on skin grafts, interested himself in the reëstablishment of the blood supply and observed that most of the vessels of the graft degenerate so that but few persist. Sixty-two hours was the earliest that he was able to demonstrate new vessels in the graft with what he thought was circulating blood in them. He felt that the new vessels often grew up inside the old ones and that a portion of the new vessels degenerated while the remainder persisted and continued to grow and form the permanent circulation of the graft.

Jugengel, an extremely careful observer, found capillaries in the fibrin-net beneath the graft on the third day, and he believed that these vessels grew upward from the host and eventually accomplished an anastomosis with the old vessels of the graft. How this anastomosis was accomplished, he did not seem to understand fully.

Goldman, in his work published in 1894, described for the first time, the process known as plasmatic circulation ("plasmatische circulation"). He felt that the graft was nourished during the first days following transplantation by an influx of lymph and leucocytes, and that the graft was caused to heal by its inherent "lebensenergie". He also stated that all of the vessels of the graft degenerated and were eventually replaced by an upward growth of vessels from the host.

Enderlen, whose work has been the most exhaustive and the most carefully executed of any done in this field, drew his observations both from clinical material removed from

patients after operation and from animal experimentation. He stated that the blood-vessels of the graft degenerated almost completely and were replaced by new ones. This, he thought, was accomplished in two ways: first, by the survival of islands of endothelium in the old vessels which after proliferation re-formed the blood channels and anastomosed with those of the host; and second, that new capillaries grow upward from the host into the graft. He did not state the mechanism of this upward growth.

BRAUN, believed that the circulation of the graft was established, at least in part, by using the old vessels of the graft. He stated that after three and one-half years, in one of his cases these old vessels were evidently in use. All of Braun's material was removed from patients after transplantation.

MARCHAND, in his classic monograph on wound healing, used the work of Enderlen as a basis to which he added some of his own ideas. He found that the vessels of the graft commenced to degenerate on the first day. Very early, however, new well-formed red blood cells were seen in the vessels, and also these vessels could be injected with an injection mass. He felt that the vessels stood in some patent relation to those of the host and formed the, so-called, "plasmatic canal." How this relation came about he could not answer, but he thought that perhaps the vessels grew up from below or that perhaps they were regenerated in a very short time from surviving endothelial elements remaining in the old vessels of the graft.

NEUHOF, in his recent monograph on "The Transplantation of Tissues," has added very little to the work of those who have already labored in this field, but rather summarizes it in the light of his experience. He states that within a few hours after the graft has been applied, leucocytes of the fibrin layer migrate into its interstices and are to be found in the lumina of its empty blood-vessels. Most of the blood-vessels in the transplant degenerate. By injection experiments he found that new vessels could be demonstrated in the cutis grafts on the third day. The newly built vessels arise by a budding of the capillaries in the fibrin layer, and the buds not infrequently extend directly into the vessels of the graft.

Thus, it can be seen that there is wide divergence in the theories and observations of those who have sought to clarify this interesting phenomenon. All agree that there is a migration of leucocytes and an inflow of lymph into the graft. The cells are first seen in the lumina of the old vessels and later they invade the whole transplant. This has given rise to the theory that a plasmatic circulation is established very early, probably within a few hours after transplantation, and that this circulation plays a rôle in nourishing the graft until such a time as the blood circulation can establish itself and take over this function. Another point on which there is unanimity of opinion is that the first new blood-vessels are found in the graft between forty-eight and sixty hours after transfer. However, several investigators have noted that well-formed and apparently living, red blood-cells were found in the old vessels of the graft at an earlier time; one observer finding them as early as the thirty-sixth hour. That there is a very active degenerative process going on in the graft, commencing almost immediately after transfer also seems established, and counteracting this, there is active proliferation of the various elements of the graft, which beginning slowly, gains impetus, striking a balance with the degenerative phase at about the sixth or eighth day and from that time on, dominating the picture until at the end of from fourteen to twenty days the graft has regained a normal appearance with perhaps some increase in the connective-tissue elements.

The tearing down and building up process in the grafted tissue varies with the status of the circulation of the transplant. In other words, it depends on the degree in which the graft is in contact with the nourishing fluids of the body. In this paper, we attempt to analyze this process and to demonstrate the factors controlling it, together with the mode whereby the new circulation is established.

METHOD

The dog has been used in this study as its abdominal wall provides an area sufficient for a series of grafts, so that it is possible to have grafts varying in age from a few hours to many days, all under identical conditions. The whole-thickness graft was chosen because it presents all the problems of the other types of skin grafts and in addition has greater bulk, which, from the point of view of the establishment of the blood supply and of the nourishment of the graft, accentuates each phase of the process.

Under ether anæsthesia, the operative procedure was carried out as follows: The skin was carefully shaved and then cleaned with green soap, followed successively by ether, alcohol and five per cent. picric acid. The grafts were all of the same size, measuring three centimetres in length by one and one-half centimetres in width, and were in the shape of an ellipse, thus making the closure of the skin possible without undue tension. The graft was carefully measured and outlined with five per cent. brilliant green and was then excised, the whole thickness of the skin being taken together with the subcutaneous fat. The fat was then carefully removed, either with a pair of curved scissors or with a sharp scalpel. The raw surface of the transplant was then placed directly upon muscle tissue and was fixed with silk sutures, in such a way that it measured the same in length and breadth as it did before excision. By this procedure, the normal tension of the skin was imitated. The wound edges were then closed over the graft. Thus the transplant was immobilized on a muscular bed, which is ideally rich in blood supply and at the same time was protected from the possibility of trauma and drying out. The operation was repeated at intervals such that at the end of an experiment we had in each animal, grafts varying in age from one to forty days, the intervals between the last ten grafts being of twenty-four hours. The animal was sacrificed at the end of the completed experiment and the whole body was then carefully injected with India ink, through the heart. The areas containing the transplants were then excised, and fixed in formalin and alcohol. Half of each graft with its muscular bed was cleared by the Spalteholtz method and the other half was cut into serial sections. By this means, it was possible to trace the vessels for considerable distances in the cleared specimens and to determine their exact relation to the graft. The serial sections were used to check the findings thus made and to determine the exact position of the new vessels in relation to the old ones in the graft. These sections were also utilized to determine the cellular content of the vessels, old and new, and to gauge the degree of degeneration and repair in the graft. A series of eight experiments was carried through.

Despite the most careful technic a graft would occasionally become infected and would slough. Needless to say, when this occurred the area was discarded from the experiment. However, the method worked so well that not only could the original grafts be recovered at the end of the experiment, but often the epithelium had spread out from the margins to cover the adjacent tissues and in the older grafts a sac or tube was obtained which was lined on the inside with healthy epithelium. The most important point

in the technic is the fact that the grafts were buried. This made immobilization and even pressure possible, provided the best conditions for growth and obviated the possibility of trauma and drying out, which conditions are difficult to obtain in surface grafts on animals.

Development of the Blood Supply.—In common with others, we have found that immediately after the graft is placed upon its new bed a fibrin net-work is formed, which seals it in place, and later by contraction pulls the two raw surfaces into closer approximation. During the next twenty-four hours, two very different processes are at work. That which is most quickly in evidence is the migration of round cells and wandering cells from the graft bed into the fibrin net-work and thence into the graft itself. These cells find their way into the old vessels of the graft in large numbers, as well as into the connective stroma, and eventually force their way into all parts of the corium. They apparently do not go beyond the corium into the epidermis. Indeed, the picture of these cells rapidly and effectively making their way about is so striking that it has been noted by all who have studied the circulation of skin-grafts. Goldman, who was the first to describe this process, thought that it must have a function in causing the survival of the graft by nourishing it during the interim when it was without blood supply and gave the phenomenon the name of "plasmatische circulation." That he was right in his supposition gains weight as we have observed that in those grafts, in which the vessels are collapsed so that these cells and the accompanying lymph cannot enter them quickly, there is a much greater degree of degeneration and sometimes complete sloughing of the transplant. In Ollier-Thiersch grafts, this plasmatic circulation probably does not play such an important rôle, because in this relatively thin tissue, the body fluids with their cellular content can more easily penetrate and nourish, and this is also true in small deep grafts as on account of their small size a blood supply sufficient to cause survival is much more quickly established.

At the same time, that is, during the first twenty-four hours, the other process at work is the development of highly vascular granulation tissue which replaces the fibrin net-work between the graft and the underlying tissues. This occurs with remarkable celerity, so that the graft rests upon a connective tissue basis which is rich in newly formed capillaries transporting circulating blood between eighteen and twenty-four hours after transplantation.

During this period, we note that degenerative processes are also going on in the transplant. The epidermis suffers most and in nearly all the grafts there is a complete slough of the epithelial layers distal to the Malpighian layer, and even in this stratum there is always a very considerable thinning of the cells. In the corium, the connective-tissue elements undergo marked destruction, including that of the vessels. The endothelium of the vessels degenerates and except in an occasional area becomes completely necrotic. The hair follicles and sebaceous glands show little degeneration and consequently slight repair. They are the most viable elements of the skin and

in a successful graft show no alteration whatever. In a sloughing graft, they are the last elements to disappear. This process continues until the seventh or eighth day, when apparently a balance is reached, and proliferation of the surviving elements is in excess of the degeneration. That this turning point is dependent upon and determined by the establishment of an adequate blood supply cannot be doubted, for in specimen after specimen vascularization reaching to all parts of the graft is first found at this time.

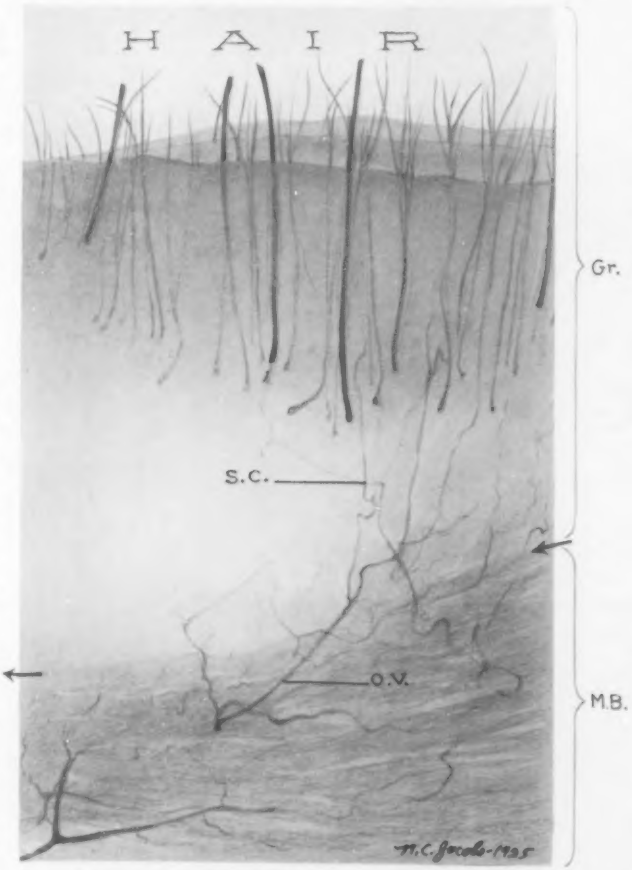

FIG. 1.—Drawing of an injected and cleared specimen removed three days after operation. Gr., whole thickness skin graft; M. B., tissue on which graft was placed; O. V., blood supply of the host tissue; S. C., surviving capillaries. The arrows indicate the lower margin of the graft. The capillaries extending well up toward the surface of the skin are well shown and are seen to be quite extensive. These capillaries are injected at this early date because they have established *anastomoses* with the vessels of the host tissues.

The sections and cleared specimens showed us that the establishment of the blood supply takes place in three ways. First, Figs. 1 and 2, the earliest connections between the vessels of the granulation tissue base and those of the graft are in the form of anastomoses between the small capillaries of the graft and those of the base. Often a small capillary in the base will establish a connection with a slightly larger vessel in the graft and this is seen sufficiently often to convince us that these are really anastomoses and not outgrowths of the capillary. The first blood supply to the graft is established in this way, taking place as early as twenty-two hours after transplantation and becoming more and more common as time goes on. Injections of such vessels, extending from the base of the corium up into the papillæ and back again, were obtained at the end of twenty-four hours, and we consider this as additional evidence that these are the result of actual anastomoses and are not outgrowths of capillaries from below.

The second means by which the blood supply is established is much slower

and takes place by the upward growth of the capillaries of the granulation tissue developing their loops and penetrating the connective tissue of the corium. Probably most of the vascularization is accomplished in this way. One can see many loops in a single microscopic field, all of the same height and with approximately the same number of branches. As the older specimens are studied, these invading loops, more and more nearly approach the Malpighian layer, and actually reach it about the twelfth day. In number, these capillaries far exceed those of the normal skin, Fig. 3, and are more numerous than those found in the older grafts. So we conclude that a great number of them subsequently degenerate and disappear.

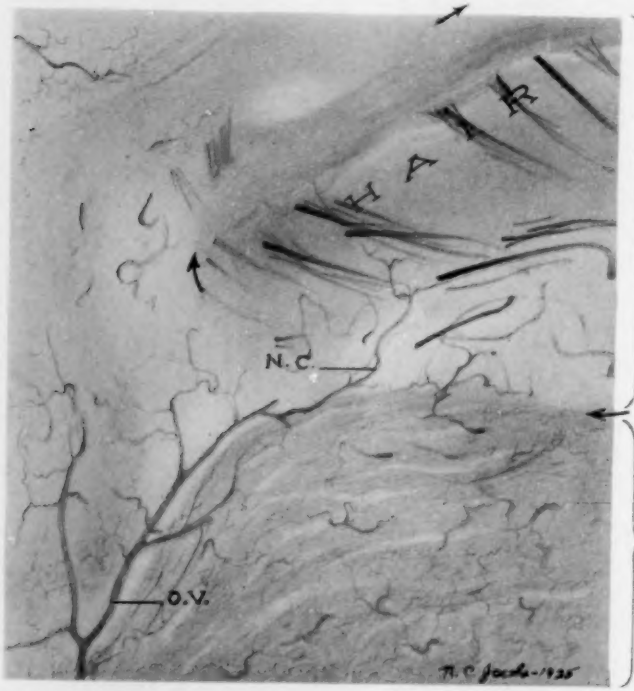

FIG. 2.—This drawing shows one end of a whole thickness graft with the superficial tissues closed over it. The specimen was removed five days after operation, injected and cleared by the Spalteholtz method. The arrows indicate the margin of the graft. Gr., whole thickness graft; M. B., host tissue; O. V., vessel of the host tissue; N. C., capillary which has anastomosed with the underlying vessel. The injected capillary in this specimen reaches upward to the tip of a papilla of the corium, *i. e.*, to the Malpighian layer. This is another example of the circulation of the graft being established by anastomosis.

A third means by which the circulation is established is as follows: A sprouting capillary in the granulation tissue at the base of the graft finds its way upward, inside one of the old vessels of the graft, Fig. 4. This forms a path of slight resistance so that the capillary grows very rapidly as compared to those which have to make their way through the connective-tissue stroma. Apparently, here and there, where there are patches of surviving endothelium in the wall of the old vessel, an anastomosis occurs and one of the smaller branches of the vessel is opened to the capillary, and thus an early circulation is established relatively high up in the corium. Cross-sections of these old vessels with the capillaries inside them are seen in the microscopic slides, but we have never found one of these large vessels completely injected, although the capillary inside it is seen injected together with some small branch of the old vessel. This, we think, is a relatively unimportant mode of vascularization, because it is only occasionally seen.

CONCLUSIONS

Although these observations have been made from experiments on animals, we are convinced that the development of the circulation of whole thickness skin grafts in the human organism is practically the same, and that certain conclusions may be safely drawn.

From the foregoing, we conclude that there are two stages in the process of actual vascularization of the graft. These are preceded by what has been called the stage of plasmatic circulation, which probably bears an important rôle in the survival of the whole thickness graft. The first stage of vascularization is supplied by those vessels which form early anastomoses with small vessels of approximately the same calibre in graft and host. The earliest that this was noted was about twenty-two hours after transplantation, and this continued to occur up to about seventy-two hours. The second stage and the most important one, as it establishes a more voluminous blood supply which eventually forms the permanent vessels of the graft, begins on the fourth and fifth day and has completely penetrated the graft by the twelfth day. At this time, the various elements of the graft are actively regenerating, especially is this true of the connective tissue of the corium, which is richly supplied with new blood-vessels. The regeneration of the Malpighian layers and those of the epidermis become active later and in some specimens are of normal thickness and appearance only in the older grafts, that is in from twenty-four to forty days.

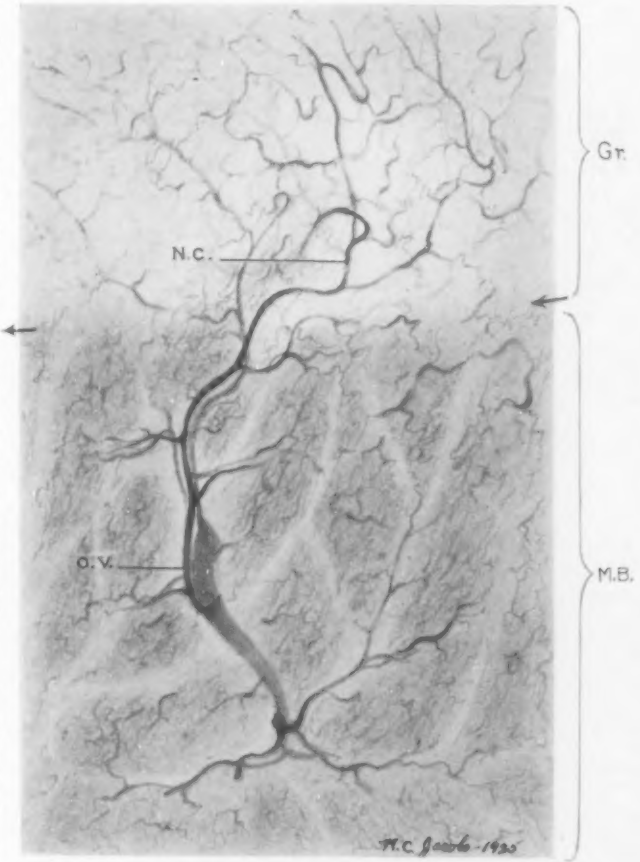

FIG. 3.—This specimen was removed on the forty-first day following operation. It was treated in a manner similar to those depicted in Figs. 1 and 2. Gr., graft; M. B., muscular host tissue; O. V., vessel of the host tissue; N. C., new capillaries. This drawing demonstrates another mode of establishing the circulation in skin grafts. The capillary net-work of the graft is the result of upward growth from the host tissues. As will be seen the plexus is extremely dense. Later this becomes greatly modified, many of the vessels disappearing.

All the larger vessels of the graft degenerate and are absorbed. Branches of these vessels may survive by becoming anastomotic with an invading capillary, but if this does not occur, they also disappear. As stated before, some of the smaller vessels anastomose with the invading capillaries and thus survive, but the bulk of the circulation in the surviving skin grafts is derived from the up-growth of capillaries from the host tissue upon which it rests. Since this is true, the problem in causing whole-thickness skin transplants to survive, centres about the period beginning at transplantation and ending at about the eighth day when these upward growing capillaries have invaded the graft to such an extent that they furnish a circulation which makes the survival of the graft secure.

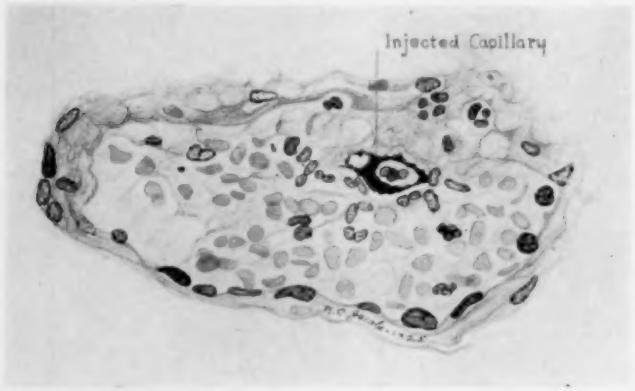

FIG. 4.—A drawing of a microscopic section, showing a vessel in cross-section about midway between the base of the corium and the Malpighian layer. The specimen was removed twenty-four hours after operation. Inside the vessel are many red blood cells and an injected capillary also with red blood cells inside it. This demonstrates a third mode whereby the circulation is established in skin grafts.

Since we know the processes, at least in part, which are at work during this period of latency, perhaps some deductions may be made applying to operative technic, which would aid the anabolic processes and reduce to a minimum those of a catabolic nature. In general, anything which tends to close or seal off the cut ends of the vessels of the transplant, will inhibit the inflow of lymph and migration of the cells into it. It has been pointed out that those grafts which show the least infiltration with monocytic cells also suffer the greatest degree of degeneration, and this induces us to believe that these cells and the lymph which accompanies them, do perform a nutritive function. The cells find their way into the graft most quickly by means of the patent vessels, so that any technic which closes them, is probably disadvantageous. Clinically, it is a common practice to remove the fat from the whole-thickness graft before transplanting it, by clipping it off with a pair of curved scissors. This removes the fat in a very satisfactory way, but it also pinches a great many of the vessels so that they remain occluded, and thus hamper the cell and lymph migration materially. This is particularly true of the thin-walled veins. The examination, under the binocular microscope of a graft prepared in this way, readily convinces one that this is true, whereas, if the fat be removed with a sharp scalpel all the vessels remain patent and provide the best conditions for the establishment of the plasmatic circulation.

The amount of tension under which the graft is placed when it is sutured into its new bed, is of the greatest importance for the same reason. If the

tension is less than that which is normally found in the skin, the contracting tissue will effectually occlude the smaller vessels and most of the larger ones. It is a better fault to overstretch, than to understretch a graft. However, the ideal is to so carefully measure the dimension and shape of the defect, that the transplanted skin may be placed under approximately the same tension that it bore before it was removed from its original site.

SUMMARY

1. The blood supply to whole-thickness skin grafts is established in three ways: by anastomosis of small capillaries of about the same calibre, by the upward growth of capillaries inside the old vessels, and by the invasion of capillaries from the host tissues, the last being the slowest means as well as that supplying the permanent vessels.

2. The earliest that we have been able to demonstrate circulation in the graft is at the end of twenty-two hours.

3. Adequate circulation, which can determine the survival of the graft is not established until the eighth day.

4. The graft is nourished in the interim by two means: a plasmatic circulation, which is most important, and by the early anastomosis of small capillaries.

5. Any technic which tends to occlude the vessels of the graft is disadvantageous.

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X-RAY AS A DIAGNOSTIC AID IN CASES OF HÆMANGIOMA

By Louis Dunn, M.D.
of Minneapolis, Minn.

The significance of phleboliths in tumors when demonstrated by X-ray is not generally appreciated by the profession, but is well known to the pathologist and the röntgenologist, the latter considering it a characteristic finding of hæmangioma. As illustrative of its usefulness, the following case history is submitted:

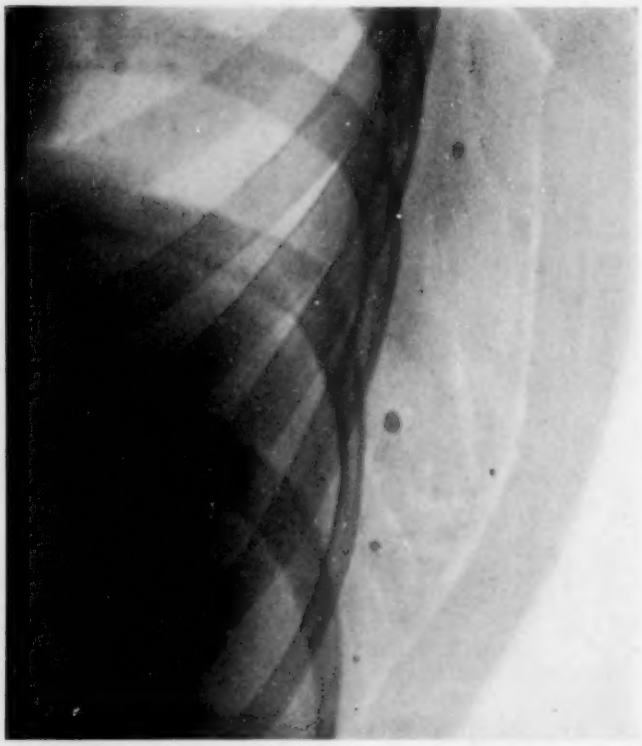

Fig. 1.—Skiagraph of chest wall, showing presence of tumor in the substance of which multiple phleboliths are discernible.

The case was that of a man, age forty-seven, weighing 180 pounds, who presented a tumor of the left chest wall in the axillary line, on a level with the inferior scapular angle. His family history was negative, except that his mother died from cancer of the intestines.

About the middle of February, 1925, after extreme exertion, he experienced a severe pain in the calf of the right leg. Two days later the calf of the left leg began to pain him. Within five days, pain developed in the right thigh posteriorly, which has continued to present time. General massage and bathing failed to give him relief but doubtless produced traumatism of a quiescent hæmangioma. He developed a pain in his right shoulder while returning to his home on the 10th of March. Again a full body massage was given. It seemed to relieve somewhat the pain in his legs, but he continued weak and he experienced night sweats with a very offensive odor. When seen later by me, he was weak with blood-pressure, 110 systolic. An enlargement was observed on his left chest wall. This was 14 cm. perpendicular by 16 cm. transversely. It was not very sensitive and was of the firmness of his muscles. He was under observation for one week, when the chest was X-rayed. The skiagraph (Fig. 1) revealed the outline of a tumor mass in which multiple phleboliths were plainly discernable. The presence of these phleboliths caused the radiologist, Dr. R. G. Allison, to suggest the diagnosis of hæmangioma for the tumor.

The patient submitted to the removal of this tumor April 14, 1925. Local anæsthesia was produced by infiltrating the chest wall for a space of 14 cm. paralleling the spinal column and 6 cm. from it including the intercostal nerves in this area. An L-shaped

incision following the infiltration from above downward then transversely forward to within 10 cm. of the sternum was employed, allowing the raising of a flap upward from the latissimus dorsi. The fibres of this muscle were separated, exposing a tumor mass, so large, that a transverse section of the muscle was necessary in order to obtain sufficient space for its removal. The tumor was attached to and infiltrated the under surface of the serratus magnus muscle. The tumor was loosely attached to the underlying ribs and was readily separated. The inferior angle of the scapula, with the serratus magnus to within 8 cm. of the sternum, was removed with the tumor. Hemorrhage was negligible.

Discussion.—The diagnosis of hæmangioma from the X-ray plate was so new to me and seemed so uncanny and improbable, that the operation was performed with the assumption that we were dealing with a sarcoma. The diagnosis by Doctor Allison was based upon the fact that phleboliths often occur in thrombosed blood-vessels. They are especially frequent in the pelvis. It is conceded that blood clots might readily become calcified in hæmangioma elsewhere. A demonstration of multiple round calcified areas in certain tumors would therefore suggest the diagnosis of hæmangioma. Ewing observes "that thrombosis and the formation of calcified phleboliths occur in dilated sinuses." McCallum says, "In all these angiomata, circulatory disturbances may occur. Infection may cause an inflammatory reaction in their substance, thrombosis of the blood channels is common and phleboliths may be found. It is not infrequent to find parts of them scarred and obliterated by such processes, with abundant pigmentation." The röntgenologist has frequently found them. Baetjer states, "The X-ray examination shows them (hæmangioma) as large soft tissue swellings. Lying within the tumors are a series of round calcified bodies having concentric rings within them. The *appearance is characteristic* and when once observed can not be mistaken." The finding of round, multiple calcified areas in tumor masses of an uncertain nature justifies the diagnosis of hæmangioma. It is with the purpose of calling attention to this diagnostic aid that this report is made.

The tumor formed a sheet of fat 3 cm. thick, 14 cm. long by 12 cm. wide. Attached to the under surface of the serratus magnus and infiltrating this muscle and fat mass were numerous large and small blood-vessels, some being 1 cm. in diameter. No capsule was present. The flat shape of the tumor is accounted for by its situation under the serratus magnus. Ewing say's, "The growth of blood-vessels is markedly influenced by the element of mechanical pressure of the circulation." The shape of an angioma is frequently determined by pressure occasioned by its situation. The flat tumor in the case reported is accounted for by its having grown between the serratus muscle and the rigid chest wall. The situation of the tumor is unusual. The wealth of blood-vessel anastomosis about the inferior angle of the scapula offers a rich field for the growth of an angioma. The extensive and frequent movements of the scapula would supply the mechanical, dilating factor to the blood spaces producing the growth of an angioma, the walls of which have not the supporting structure of a normal blood-vessel.

The muscular pains previous to operation and the muscular weakness which developed in groups of muscles in his legs following the operation were attributed, by the neurologist, to a beginning multiple sclerosis. This had nothing to do with the growth of the hæmangioma, which must have been of long standing, except that the massage which had been so vigorously applied produced a trauma resulting in a thrombosis and the subsequent formation of the phleboliths.

Dr. R. G. Allison has seen at the University Hospital (Minn.), three cases of hæmangioma in which phleboliths were present. The hæmangioma had been present from birth and were situated on the hand, on the forearm and over the deltoid. The ages were, respectively, thirty months, four years and six years.

The conclusion one is justified in reaching is that age is not a factor in the development of phleboliths, but that the situation of the hæmangioma making it more liable to either traumatism or infection is the factor that invites thrombosis and later the deposit of calcium in the blood clot.

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MYOSITIS OSSIFICANS CIRCUMSCRIPTA

A CLINICAL AND EXPERIMENTAL STUDY

By Adam Gruca, M.D.

of Lwow, Poland

ASSISTANT AT THE SURGICAL CLINIC OF THE JOHN CASIMIR UNIVERSITY
DIRECTOR, PROF. DR. HILARY SCHRAMM

Although the appearance of parosteal bone within muscle following trauma is known for over two centuries (Fay), though the condition is not a very rare one, as the number of cases reported exceeds some hundreds, and its course, forms, its clinical picture and some points of etiology are minutely described, still many questions connected with it, as its place in pathology, its relation to injury and other diseases of movement apparatus, and above all, the question of its genesis, are not sufficiently explained. By experimental studies the questions could not be solved up to now. Clinical observations therefore are the only means of solving the problem, and any case that serves to reveal some new points should be reported. Therefore, I think it advisable to describe some cases which have occurred in the course of the last three years at the surgical Clinic of the John Casimir University of Lwow.

REPORT OF CASES

Case I.—A. G., male, aged forty-six. Family history unimportant. Has never been seriously ill. In 1916, twice wounded on the left leg. During the last two years of war, at the Italian front, he was obliged to walk much through mountains. After each long march he felt pain in the anterior upper third of the right thigh. After some rest the pain disappeared. At various medical examinations nothing abnormal could be found in the ailing region.

On his return from the war, 1918, the trouble disappeared. He was quite well, working as a joiner until last year, when the pain appeared again. Three months ago he noticed in the upper third of the right thigh an induration in the painful region. The extremity deviated outward and he began to limp. Two months ago he noticed in the painful region a swelling gradually increasing in size. There has never been a direct injury to the now painful region. The physical examination after his admission to the Clinic resulted as follows:

A strong man. Internal organs normal. The right leg in slight outward rotation, not shorter than the left. The right inguinal region below the anterior spine of the ilium and the upper third of the thigh at the anterior and lateral aspect diffusely swollen. The skin, excepting a slight dilatation of veins, unchanged. In the middle of the swelling was palpable a hard mass, extending from below the spina ilei anterior superior downward to the internal condyle of femur, which ended at the level of the lower limit of the upper third of femur, movable, unattached to the bone or skin, not especially tender. The mass was of bony consistency. Flexion of the thigh and inward rotation limited, abduction and extension normal. On the left calf two large soft scars not attached to the bone. Wassermann reaction negative.

The X-ray examination revealed just below the anterior superior iliac spine a shadow about 1 cm. in diameter, about 15 cm. long, well limited, showing in its centre a lighter space like bone-marrow, unattached to the femur. (Fig. 1.) (The hip-joint was unfortunately not included in the photographic plate.) Diagnosis: *Myositis ossificans.*

Operation, March 1, 1924. An incision was made along over the mass. The mass was then removed. It was surrounded by a hard capsule of scar tissue, lying in the antero-lateral bundles of the quadriceps muscle, grown strongly together with them and attached by a strong fibrous tissue bundle to the spina ilei anterior inferior. At the upper end of the mass at the level of the hip-joint a cyst was opened, grown with the bony mass, filled with about two hundred c.cm. of thin bloody serous fluid. The cyst communicated with the hip-joint cavity. The hip-joint capsule, muscles, fascia and skin were closed with sutures.

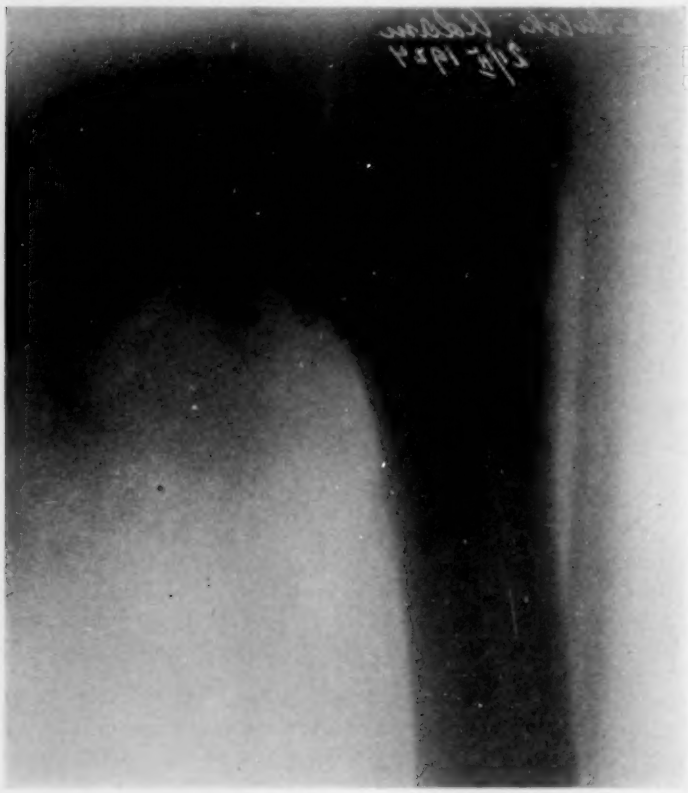

FIG. 1.—Case I. Bone plate in the quadriceps femoris muscle.

During the next three days fever till 39 degrees and some spontaneous pain.

March 9, from the upper end of the wound escaped some serum-like fluid.

March 18, patient begins to walk, but feels discomfort at the region of the hip-joint. March 25, discharged.

He returned a month later complaining of tenderness at the hip-joint and inability to walk. The Röntgen-ray examination showed destruction and deformation of the head of the right femur and acetabulum and a triangular exostosis at the anterior inferior iliac spine, losing itself gradually in the soft parts without distinct limits. Diagnosis: Arthritis deformans coxæ dextr.

The bony mass removed was irregularly quadrangled, about 15 cm. long, 1 cm. in diameter, surrounded by a strong fibrous capsule. The mass was thicker at the upper, than at the lower extremity.

*Microscopical Examination**.—Transverse section of the mass: At one side of the periphery of the section, an island of well-preserved skeleton muscle was to be seen, surrounded by fibrous connective tissue, some of them degenerated and atrophied. In other parts fibrous connective tissue, partially hyaline changed, with only slight amount of nuclei and very few blood-vessels, containing here and there small plates of osteoid tissue, surrounded by osteoblasts. The connective tissue near these bone islands appeared more loose and showed many nuclei, arranged concentrically along the osteoid plates, so that

* All microscopical pictures were interpreted by Dr. H. Schuster, Pathologist of the University, and all the microphotographs were furnished by Dr. J. Misinski, Assistant of the Institute of the Descriptive Anatomy of the John Casimir University.

their limits were not very sharp. It appeared as if the osteoid tissue originated directly from the connective one. The bony trabeculæ were either homogeneous or there were in their centre distinct spaces filled with fat or loose connective tissue forming bone-marrow.

Near the described plates at the other side of the section one met with a large island of typical spongy bone tissue sharply limited from the neighborhood. This island had an oval outline, size 0.6 by 1 cm. The trabeculæ of typical bone structure were surrounded by an abundance of osteoblasts. The bone-marrow contained, as above, abundant fatty or loose connective tissue, joining here and there the surrounding fibrous tissues. The last was seen in some places to extend between the bone trabeculæ and become fat tissue. Cartilage traces were found in the middle of some bony plates. Nowhere were inflammatory symptoms apparent. (Fig. 2.)

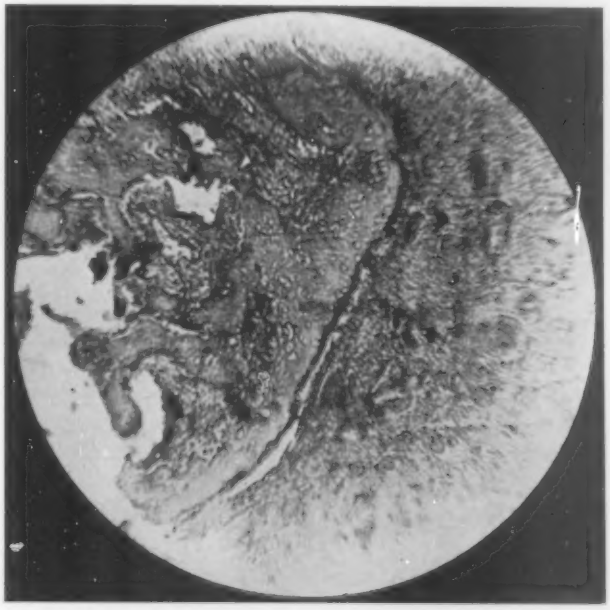

FIG. 2.—Microphotograph of the plate removed in Case I. Transverse section. (50 x 2.)

CASE II.—B. F., aged twenty-eight, a sportsman. Family history unimportant. Never experienced any serious illness. July, 1923, at a football match, a fellow player struck him heavily with his knee on the upper part of the right thigh. The blow was so severe that he fell down. After a while was able to continue the match to the end. On the same day the injured region became swollen and discolored considerably. The severe pain by touching and movement caused him to remain in bed for the next four days. He was treated by massage and bathing.

On the sixth day he got up and went about. Six weeks after the accident, although the region was somewhat swollen, he played again and was hit once more, but slightly, on the same spot. The pain this time was so severe, that it was necessary to carry him home. He limped three days. Three months after the first injury the swelling had decreased slightly, only aching on movement. At the end of last year the discomfort had increased.

The X-ray examination made four weeks after the first trauma showed below the top of the right major trochanter a shadow about 7 cm. in length, 1½ cm. in diameter, irregularly limited, of unequal power, parallel to the axis of the femur, but separated from it by a narrow zone of light. The femur bone was unchanged.

Diagnosis: Myositis ossificans incipiens. (Fig. 3.)

Physical Findings, March, 1925.—An athletic, well-built man. General examination essentially negative, excepting caries dentium.

At outer aspect of the right thigh, about 7 cm. below the top of the trochanter, a mass was palpable of bony consistency, about 5 cm. long, thick as a finger, attached to the shaft, tender on pressure, especially on the ends. Flexion at right hip-joint over 90 degrees possible. By maximal flexion the region of the anterior superior iliac spine is painful. At abduction a sharp pain below the trochanter major and at the hip-joint. Inability of crossing the right thigh over the left owing to pain.

Röntgen-ray examination: About four fingers below the top of trochanter begins a shadow about 6 cm. long, 1 cm. in diameter, cigar-like, sharply pointed, attached to the femur with a pedicle, the shadow of which was brighter than of the rest of the mass. On the upper margin of the acetabulum there is an exostosis about 2 cm. long triangled, pointed outward and downward. On the head of the femur itself, externally and internally, two small spots of bone atrophy. (Fig. 4.)

Case III.—J. K., aged thirty-four, a policeman, fell and struck his right knee four years ago. Since that time walking somewhat painful.

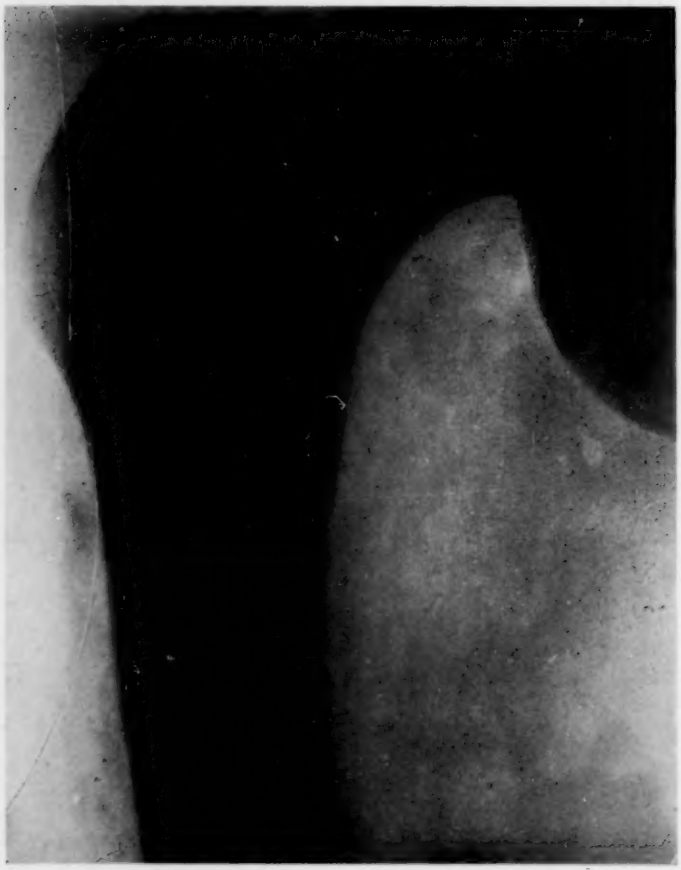

Fig. 3.—Case II. Four weeks old parosteal callus.

Röntgen-ray examination revealed at the right thigh anteriorly, about 1 cm. above the patella, an oval shadow, 4 cm. long, 1 cm. large, irregularly shaped, of unequal intensity, nearly 1 cm. distant from the femur, when the knee is flexed to 135 degrees. Otherwise the knee-joint normal. (Fig. 5)† The mass was of bony consistency, tender on strong pressure, well limited, movable, attached to the posterior surface of the quadriceps tendon.

Diagnosis: Myositis ossificans of the quadriceps muscle. Was not operated because of but little disability.

Case IV.—M. I., aged sixteen, a girl. Parents and other members of her family well. She was never seriously ill till four years ago, when she noticed a pain in the left hip-joint, without any trauma preceding. The pain increased from time to time, being felt mostly in the evening.

State, December 1, 1924.—Girl of delicate stature, badly nourished. Excepting a shortening of the percussion time over the top of both lungs, the internal examination revealed nothing abnormal. The muscles of the left leg very atrophied. The leg 9 cm. shorter than the right, fixed in adduction, extension and inward rotation. Movement of the hip-joint considerably limited: abduction quite impossible. Pressure on the trochanter painful.

X-ray examination showed total destruction of the head of femur and of the acetabulum. The last laterally and sagittally displaced. On the inner side of the iliac bone in

†I am indebted to Doctor Lenartowski for placing the X-ray plates of Cases iii and viii at my disposal.

the region corresponding to the bottom of acetabulum an abundant callus. The left sacrospinous ligament ossified.

Diagnosis: Luxatio coxæ supracotyloidea pathologica. Ossificatio ligamenti sacrospinosi. (Fig. 6.)

CASE V ‡.—C. R., male, aged sixty-five, butcher, 1922, was complaining for the last year of pain in both lower extremities and spastic contracture of the muscles of both thighs. Not an habitual drinker. Wassermann test negative. The X-ray examination of the pelvis, vertebral column and both thighs negative.

During the next year complete ankylosis of both hip-joints developed, also contractures in the knee-joints. The pain increased in intensity and reached to the pelvic region. Repeated X-ray examination showed the joint cavity of both hip-joints disappeared, the heads of both femurs flat and grown together with the acetabulum. The margins of acetabulum deformed and enlarged. Ossification of both sacrospinous ligaments, especially of the left. Roughening on the trochanter minor giving to it a fungous shape. The margins of the fourth and fifth lumbar vertebræ uneven beak- and hook-like deformed. (Figs. 7 and 8.)

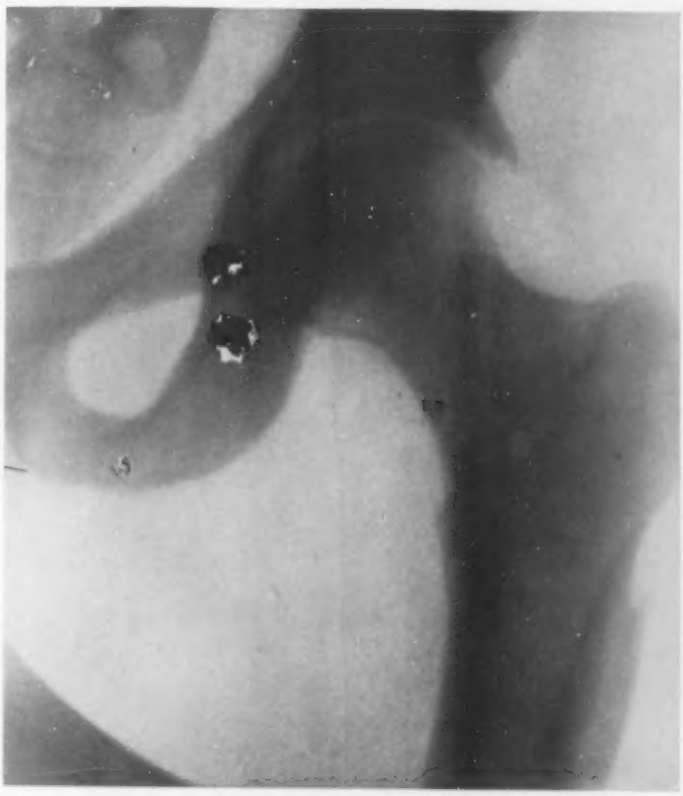

FIG. 4.—Case II. Callus evident in Fig. 3, twenty months later.

Diagnosis: Spondylitis ankylopœtica with ossification of the sacrospinous ligaments.

CASE VI.—S. K., eighteen years old; scholar. No constitutional disease among the members of his family. Has never been seriously ill, excepting measles ten years ago. During last four years, while playing football, received several blows on both legs without any complication. Thirty-four days ago (May 15, 1925) was struck by a thick iron tube on his left thigh. The pain it caused was so trifling that he could walk till evening, feeling no special discomfort. The next day the contused region became swollen and discolored, tender on pressure but not specially painful when he was walking. The knee could be flexed only to about 135 degrees. Within the five days the tenderness disappeared almost completely, only a circumscribed swelling remained. The flexion of the knee returned also to normal limits. After a week he played football again, feeling no discomfort. Two days later, however, a severe pain on movement reappeared

‡I am indebted to Doctor Begleiter for the history and to Doctor Meisels for X-ray photographs of this case.

suddenly, forcing him to keep at rest for eight days. The mentioned swelling increased gradually and at the same time the knee became stiff again. Since two weeks he walks about. The pain on movement decreases slowly. The swelling remained unchanged.

June 18, 1925, thirty-four days after the accident, general physical examination negative. The middle third of the left thigh at the antero-lateral aspect somewhat diffusely swollen, covered with normal skin. In the middle of the swelling, under a layer of somewhat hardened muscle, a hard irregular mass is to be felt, not grown together with the skin, but apparently attached to the shaft of femur. The mass measured about 12 cm. in length, was about 4 cm. broad, indistinctly limited, its borders tender on pressure. Flexion at the knee-joint possible only to about 125 degrees. Extension of the knee, also movement in the hip-joint normal.

FIG. 5.—Case III. Parosteal bone in the quadriceps muscle.

X-ray photograph shows at the damaged region a spotted shadow, indistinctly and irregularly limited, separated from the femur by a narrow zone of light. The femur bone was unchanged.

Diagnosis: Myositis ossificans of the quadriceps muscle. After a month the symptoms disappeared without any treatment, excepting the circumscribed swelling.

CASE VII.—J. C., aged sixty-five, a farmer. Has never been seriously ill. Five weeks ago (December 29, 1924) his right arm was bruised strongly by a passing carriage. At the moment of trauma he felt a severe pain and paræsthesia in the fingers. Soon after the accident the arm became swollen and later discolored, but he was still able to work for another two days. Then he was obliged to stop working owing to pain when moving the arm. Within two weeks the diffuse swelling disappeared, but above the external condyle there remained a hard mass, slowly increasing in size. At this time the right hand began to lose strength and the fingers stiffened as well as the elbow-joint.

Examination February 1, 1925. A badly nourished man. General examination negative. At the external aspect of the right arm, about three fingers above the external condyle of the humerus, is palpable a mass, large as a hen's egg, somewhat irregular in outline, tender especially at its lower extremity, apparently attached to the bone. The skin above it is unchanged. Extension of the forearm considerably limited. Flexion not hindered. Active extension of the hand and of the fingers in the inter-

phalangeal joints impossible. Flexion possible but with very little strength. Passive movement normal.

X-ray examination showed a not homogeneous irregular shadow nearly 8 cm. in length, 1½ cm. in breadth in the muscles of the distal external half of right humerus, separated from the last with a light area about 1 mm. in diameter, the outline and structure of bones forming the elbow-joint unchanged. Calcification of the right radial artery. (Fig. 8.)

FIG. 6.—Case IV. Destruction of the hip-joint. Sacrospinous ligament ossified.

Diagnosis: Ossifying myositis causing a p a r e s i s of right radial nerve.

W a s s e r m a n n reaction negative. B l o o d coagulation time 6 minutes. Calcium c o n t e n t s of of blood, measured with the method of de Waard 35 mg. per cent.¶

At the operation (February 5, 1925) an incision was made over the mass exposing t h e radial nerve just below the mass. The n e r v e was running through the middle of the mass. The n e r v e was freed by dissection and the mass separated from the periosteum of humerus and removed. As the periosteum was found thickened, it was cut away. The cortex of the bone was normal. The removed mass was of cartilaginous consistency (could be cut with scissors), its surface was grown together with bundles of the brachioradial muscle.

The post-operative course uneventful. After two weeks, extension of the fingers became possible and one month later the function of the hand was quite normal. The extension of the elbow-joint improved also.

April 8, a recurrence the size of a small nut at the upper end of the incision was noticed, but without any disturbance of the function of the arm.

Microscopical examination of the removed mass: A section just over the periosteum at the bases of the mass showed connective tissue partially rich in blood-vessels and cells, partially more fibrous with but few vessels. Amidst this connective tissue there are bundles of muscle, mostly degenerated and separated from each other by connective tissue. In the last trabeculæ of spongy bone, surrounded in abundance by osteoblasts. Connective tissue near the bone trabeculæ contains a mass of nuclei, arranged concentrically

¶ Calcium salts were measured by Dr. W. Jankowska, assistant of the Chemic Institute of the John Casimir University.

along the bone plates. It would suggest that osteoblasts and bone were arising from the named cells. The bone plates containing definite lacunæ have had typical bone structure or were osteoid tissue. At some places slight evidence of cartilage in the centre of bony plates or bone tissue resembling a cartilaginous structure, with many round lacunæ. The marrow was composed of very loose connective tissue, in which were met at times enlarged sinusoid blood-vessels and areas of hemorrhage. The connective tissue of the marrow seemed to arise distinctly from the fibrous tissue, surrounding the bone plates. (Figure 10.)

FIG. 7.—Case V. Ossification of sacrospinous ligament. Deforming changes at the trochanter minor.

Many other sections from other parts of the mass corresponded to the description as above.

CASE VIII.—R. M., aged twenty-five, a workman. No definite history of any injury could be elicited. Was occupied a considerable time at mending telegraph wires. At this work his both (upper) arms became somewhat painful on movement for some weeks. At the left arm the pain slowly subsided and then he noticed in the substance of the muscle a hard not tender mass, causing but little discomfort by flexing the elbow-joint. Up to date the mass has remained unchanged. The spontaneous pain at the right arm lasts until now.

Examination, April 4, 1925: A well-developed man. A bony hard mass is palpable in the substance of the biceps muscle of the left arm, tender by strong pressure only, about 10 cm. long, thick as a finger, not connected with the shafts of humerus. The limits of the mass were distinct when the muscle was loose, but not when contracted.

Röntgen-ray examination showed: In the left biceps muscle a bony mass, measuring 9 cm. in length, at the lower extremity 1½ cm., at the upper ⅓ cm. wide, from the shaft 1½ to 3 cm. distant, sharply shaped, of not homogeneous consistency. The humerus bone and the neighboring joints unchanged. (Fig. 11.)

Diagnosis: Ossifying myositis at the biceps muscle of the arm. Was not operated because he felt little discomfort.

CASE IX.—J. K., aged twenty-four, a workman. Eight weeks ago struck on his left elbow from behind and then typical traumatic symptoms. X-ray examination, December 22, 1924, shows the outline of the left olecranon irregular, deformed and

roughened, but without any destruction of cortex. Nearly 1 cm. above the top of the olecranon a shadow about 2 cm. long, ¾ cm. broad, irregularly shaped of not homogeneous density. (Fig. 12.)

The region of olecranon enlarged and tender. By palpation one felt a bony, hard mass, the size of a nut, by pressure tender, when the muscle is relaxed, somewhat movable from side to side. The movement in the elbow-joint limited.

Diagnosis: Myositis ossificans in triceps muscle. After some weeks the movement improved. No operation.

Case X.—M. L., aged twenty, female. The family history insignificant. Has never been seriously ill. Fell and struck her left elbow seven weeks ago. Just after the accident the elbow became swollen and tender and could not be flexed. Since that time no attempt at reposition has been made. The diffuse swelling disappeared after some days, but the limitation of motion and discomfort when attempting it remained.

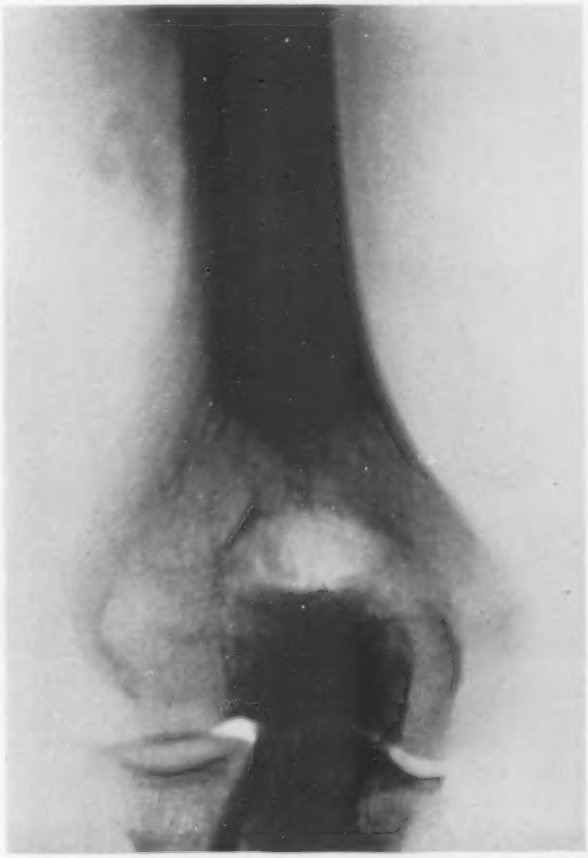

Fig. 8.—Case VII. Five weeks old callus in the brachioradialis muscle.

Examination, April 4, 1925: A well-nourished female of middle stature. Internal organs negative. Left arm extended, forearm fixed at about 145 degrees. The region of the elbow irregularly outlined and deformed. The skin over it pigmented. The lower end of the humerus could be felt in the cubital fossa, but somewhat irregular in shape and size. Both forearm bones dislocated backward. The motion was considerably limited.

X-ray examination revealed backward dislocation of both forearm bones. At the posterior surface of the lower end of the humerus under the triceps tendon and along the articular surface of the humerus anteriorly, a shadow not homogeneous and irregularly shaped. Diagnosis: Myositis ossificans after backward dislocation of left forearm. (Fig. 13.) Calcium salts content in blood 15 mg. per cent.

At the operation, performed April 14, 1925, after transverse section of the olecranon was found a mass of scar tissue of cartilaginous consistence, 1½ cm. thick, connected closely with the external surface of the articular capsule. At the front of the elbow-joint also the articular membrane was even at its inner side and of normal outlook, from outward grown close with similar masses occupying a space between the articular end of the humerus and the brachialis internus tendon and substance. The articular cartilage appeared normal.

Microscopical Examination.—A transverse section of the mass removed from the anterior part of the joint capsule showed at the inner surface a fibrous connective tissue with typical cells and fibrillæ, the last running parallel to each other and to the joint cavity. Nearer to the middle of the section the connective tissue became loose and vascular and contained more cells. The last gradually losing their spindle shape, appeared more regular and then round. The intercellular substance also assumed slowly a more homogeneous hyaline appearance and color of a cartilage. Thus the connective tissue there transforms without distinct limits into cartilage, forming in the section a long homogeneous plate. The cartilage in the other half of the section ossifies, adjoining without distinct limits to an island of spongy bone, irregular and oval in shape. Between the trabeculæ of typical bone there were large marrow spaces filled with a vascular loose connective tissue. The trabeculæ were in some places, especially at the outer side of the plate, encapsulated by connective tissues rich in round nuclei and signs of quick growth and contained here and there traces of cartilage in their centre, surrounded by typical bone or osteoid tissue. At the outer side of the bone island the transition of bone structure to a cartilage or fibrous tissue is not sharp. The last shows there many places of inflammatory infiltration and abundant formation of granulation tissue.

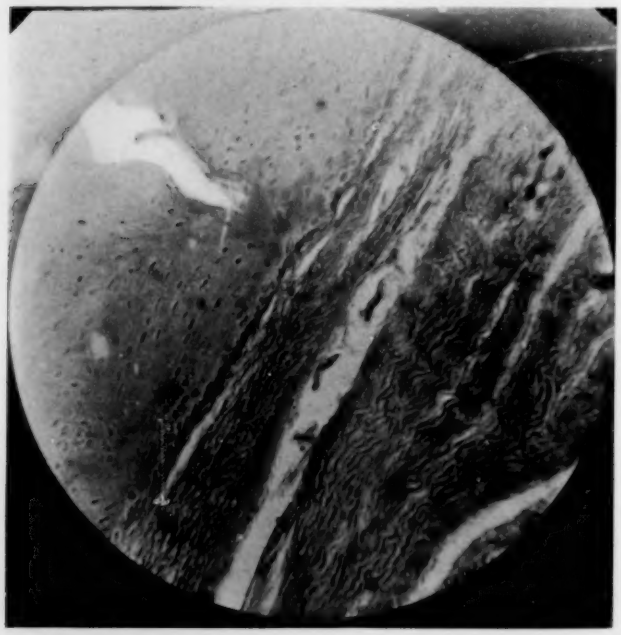

FIG. 9.—Case XVII. Microphotograph of the mass removed from the laparotomy scar. Transversal section. (50 x 2.)

In other sections near to the former abundant focus of inflammatory infiltration and granulations tissue in various degrees of maturation were seen close to scar islands, very poor in vessels and cells, but no traces of ossification. There were also numerous remains of old hemorrhages.

All this would suggest that the primary appearance were inflammatory changes near to the joint capsule and within itself. The young granulation tissue, originating from the joint capsule, organizes the hæmatoma and crushed tissue pulp in the neighborhood, transforming itself into fibrous tissue, cartilage, and at last into bone.

CASE XI.—W. P., aged twenty-two, a workman. Dislocated both forearm bones backward at right elbow-joint six years ago. Since that time the elbow became nearly stiff and deformed. Every attempt to move it was painful. Some weeks ago the pain increased in intensity. No attempt at reposition had been made.

Findings, November 14, 1924: Right elbow fixed in extension of about 135 degrees. The outline of the elbow-joint indistinct and much deformed. The muscles of the arm and forearm considerably atrophied. In the cubital fossa palpable the articular end of the humerus somewhat irregular and thick shaped. The triceps muscle tendon and distal part of the muscle itself hard and fixed. The active as also passive movement nearly entirely absent.

X-ray picture showed backward and outward dislocation of both forearm bones. The triceps muscle tendon and distal part of the muscle itself, as also the space between it and the humerus, giving bony shadow. The space between the dislocated bones, forming the elbow-joint in past and in the front of the joint filled with bony masses, partially irregularly shaped, of unequal density. The coronoid process of ulna, as also the olecranon process, roughened and deformed. (Figs. 14 and 15.)

Diagnosis: Extensive parosteal bone formation following backward dislocation of right forearm.

The patient refused to be operated upon.

CASE XII.—S. M., aged twenty, female. Posterior luxation of forearm by falling three days ago, the same day replaced by a physician. The X-ray picture done three days later (October 5, 1922) revealed the relation of bones in left elbow as also their outline and structure entirely normal. The region was then diffusely swollen tender and discolored. Within two weeks the diffuse swelling disappeared partially and the patient began to move her arm. The movement was limited and painful. This discomfort increased for a while and then stopped.

FIG. 10.—Case VII. Microphotograph of the removed mass. (40 x 2.)

On calling at our Out-patient Department, January 30, 1923, a mass was palpable within the muscle substance over the lower end of left humerus above the cubital fossa, size of a hen's egg, hard, somewhat movable from side to side, not very tender. The movement in the elbow-joint was limited and painful.

The X-ray picture showed in front to the lower humerus end a shadow till 4½ cm. long, about 2 cm. broad, irregularly shaped, not homogeneous, with darker and lighter areas, apparently not attached to any bone. (Fig 16.)

Diagnosis: Myositis ossificans in the brachialis internus muscle. Massage, movement and bath were then advised, and the patient returned to her country physician. Probably improved, as she did not call again.

CASE XIII.—M. I., aged forty-four, female. A dislocation of right elbow backward five weeks ago and the same day reposition by a country physician. Subsequently the elbow became swollen and discolored. Ten days later, beginning to move her elbow, she noticed that the movement was considerably limited and painful. As the discomfort increased she called at our Out-patient Department, December 31, 1924.

X-ray examination then revealed in front of the trochlea a mass small as a nut, irregularly and indistinctly outlined, not homogeneous, separated from the trochlea about one centimetre.

The cubital fossa was that time somewhat tender. The extension of forearm considerably reduced and painful.

Rest of arm and a compress, so long as the region remains tender, was then ordered

and movement after ceasing of tenderness. Five weeks later a second X-ray examination showed the shadow became somewhat smaller, more distinct and denser. The limitation of motion apparently diminished.

Case XIV.—M. N., aged sixty, a female. Fell and struck on her right shoulder a year prior to examination. Since that time discomfort and impairment of motion at right shoulder-joint, in last few months gradually increasing.

X-ray picture revealed a deforming arthritis of the right shoulder-joint and ossification of the sacrospinous ligament. On skeleton bones no traces of fracture.

Case XV.—W. S., aged thirty, a sportsman. Has ridden horseback habitually for many years. In 1916, acute polyarthritis. In 1921, at war, wounded on right thigh. The wound healed rapidly without any complication. The same year febris recurrens. During last seven years a parosteal callus developed at both arm muscles and at right thigh after exercises. At first the symptoms followed their usual course. After a time the bone masses disappeared. In 1923, after running some distance, pain and swelling on both thighs, especially at the left one, suddenly appeared. He was treated for some weeks in the military hospital. A hæmatoma was then found in the antero-lateral muscles group of the left thigh. The hæmatoma recurred after some punctures. There developed then an abscess and in the pus a bony sequester was found. Repeated X-ray examinations of bones of the skeleton were entirely negative. After treatment with autovaccine the wound healed.

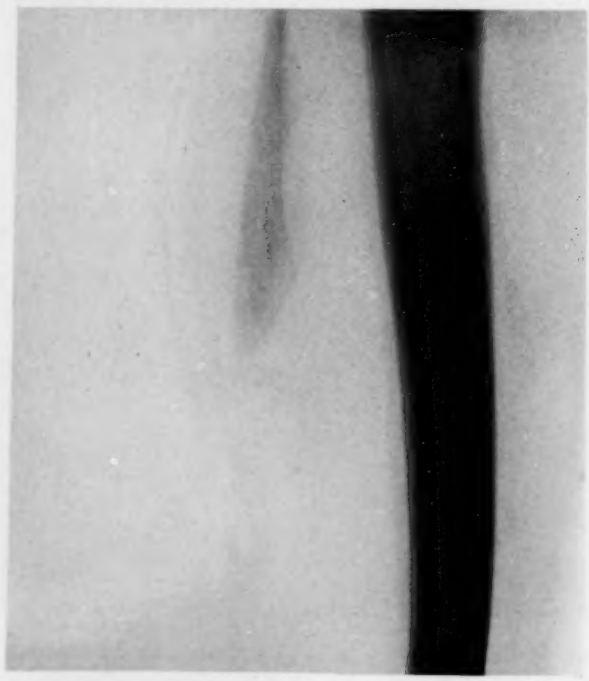

Fig. 11.—Case VIII. Myositis ossificans in the biceps brachii muscle.

The patient was otherwise completely well. Examinations of urine, blood, internal organs were essentially negative. There was also no constitutional disease.

I am indebted to Doctor Janusz (Lwow) for the history of this case.

Case XVI.—Dr. H. Schuster at the Institute of Pathological Anatomy of the John Casimir University, found (July 22, 1925), in a post-mortem examination of a forty-six year old man, M. F., being a prisoner, a chronic inflammatory process along the whole length of the vertebral column with scar and bone formation, occupying the substance of both iliopsoas muscles, especially at the right. The periosteum of the vertebræ, as well as the perivertebral tissues, were thickened and uneven. The muscles substance was hardened, as if inflamed, and contained several scar islands, and among them many narrow-bone trabeculæ, arranged longitudinally to the muscle fibrillæ, appearing in a transverse section as about one month old callus. The particular vertebræ were normal in outlook, not inflamed or deformed.

In addition the retroperitoneal, mesenteric, the cervical and left axillary glands were enlarged, pale, hard, and surrounded by a hard connective tissue, grown closely with

the glands. There was also an endocarditis verrucosa recens of the semilunar valvulæ, a chronic slight endocarditis of the tricuspid valvulæ, a hyperplasia and enlargement of the heart, an ascites and hydrothorax of both sides with subsequent atelectasis and compression of both lungs, a chronic fibrous partially ossifying leptomeningitis, a hæmostasis in liver and kidneys and a papilloma of the stomach. Other organs normal.

The man was treated a week before he died in the internal department of the General Hospital of Lwow and to Doctor Ciepielowski I am indebted for the history of this case.

There was no constitutional disease or a serious illness in the past. For a considerable period of time he experienced pain in the abdomen. Then developed a swelling of left upper extremity and left part of the thorax, later of the abdomen, and about a week ago both lower extremities became swollen. He drank much, prior to the war.

On examination, July 17 1925: Lymphatic glands of left supraclavicular fossa and of left axilla enlarged, small nut size, not attached to the skin. Both pleural cavities filled with a free fluid, reaching the level of the middle of the scapula. Free fluid in the abdominal cavity. Swelling of left arm and both lower extremities.

Blood examination: White cell count, 12,000; neutrophile polymorphonuclear leucocytes, 88 per cent.; lymphocytes, 8 per cent.; mediate forms, 4 per cent.

FIG. 12.—Case IX. Traumatic ossification in the triceps humeri muscle.

Neurological examination: Hæmiplegia cruciata: Paresis of right facialis nerve, paralysis of left upper and paresis of left lower extremity.

Microscopical examination of the removed psoas muscles has given unexpected result; it showed an endothelioma malignum. There were foci of neoplasmatic cells, different in size, lying within fibrous connective tissue The last, growing between the muscle fibrillæ, compressed them, causing their atrophy and destruction. Otherwise many islands of cartilage, osteoid and bone tissue, passing into each other and into connective tissue, without distinct limits, originated undoubtedly from connective tissue, forming the stroma of the tumor. Nowhere traces of inflammatory infiltration were found.

CASE XVII.—F. M., aged forty-nine, a farmer. Family history of no importance. When he was twenty years old icterus. For a considerable period of time suffered from stomach trouble. Fifteen months ago (June, 1923), a gastrectomy was performed

in our Clinic because of chronic gastric ulcer. (Microscopical examination of the specimen was then not done.) The post-operative course was normal, the skin incision healed by primary intention, without inflammatory reaction and patient felt completely well for nearly a year. Then he noticed an enlargement of the upper left part of the abdomen and a hard not tender mass at the middle of the scar. A month before his readmission to the Clinic the pain reappeared after taking food.

At the examination, December 11, 1924, was found: A badly nourished cachectic man. Head, neck and chest negative. At the enlarged upper part of the abdomen a tumor was palpable, occupying a space between both nipple lines sideward and two fingers below the navel, hard, slightly tender by pressure, moving only little with breathing. At the middle of the laparotomy scar which was smooth and thin, beginning one finger breadth below the xiphoid process, ending at the level of umbilicus, a mass was lying within the fascia, about 6 cm. long, ½ cm. thick, somewhat more on the left side of the white line situated, not tender, not attached to the skin, giving in X-ray picture a definite shadow. A carcinoma of the stomach probable.

FIG. 12.—Case X. Posterior dislocation of the elbow. Ossification of the joint capsule and under the triceps tendon.

At operation, December 18, 1924, the hard mass from the scar was removed. It proved to be a bone, surrounded by scar tissue. By removal of it the capsule of right rectus muscle was opened. The mass in the abdominal cavity proved to be an inoperable carcinoma. The abdomen was closed in layers. The post-operative course was uneventful.

Macroscopically the removed bone appeared about 6 cm. long, 1 cm. large, at the anterodorsal aspect slightly bent, according to the depth of epigastrium, flat, very hard, at the lower extremity somewhat wider, connected strongly with the scar tissue of the white line, proved to be more resistant to decalcification than a tooth tissue. (Fig. 17.)

Microscopical Examination.—At the transversal section of the mass there was at the circumference an abundant fibrous tissue, containing in some places traces of hemorrhage and degenerated muscle fibrillæ. The middle of section occupied an island of typical bone, oval in shape, size ½ by 0.3 cm. The bony tissue had the character of compact bone showing the typical Havers canaliculi and lacunæ arranged concentrically along the Havers canaliculi as in normal bone. The vessels of the canaliculi were connected with the vessels of the neighboring tissue, the latter being very vascular in such

places contained numerous large nuclei, as in the preceding cases. The entire bone island sharply limited from the enveloping tissue has had at its margins in some places a layer of osteoblasts, forming apparently a new bone. Far from the bony plate there was a group of giant cells arranged round a foreign body, probably a piece of catgut ligature.

Classification.—According to the last probable cause due to the development of parosteal bone, myositis ossificans could be divided into the following groups:

1. *Myositis Ossificans Traumatica.*—a. Bone formation following a severe single injury by blunt force. This is the most frequent form one meets with. Schultze found it 232 times out of 296 collected cases. It is common in some occupations, as horse servants, workmen, sportsmen. As the most frequent trauma was noted a stroke with a horse shoe, by the fall of a heavy object, or by falling. To this group belong our Cases II, III, VI, VII, IX. This form develops most frequently in the anterior and lateral aspect of the thigh and upper arm. Very rare are such localizations as pectineus muscle (Graf, Carleton, Bowen), masseter (Borchardt), or as temporal, gluteal or thumb muscles (quoted by Strauss). To this group belongs also ossification of joint capsule and ligaments following a single blunt injury, as, for instance, ossification of coraco-acromial ligament reported by Marshal, ossification of trapezoid and conoid ligament by Grune, ossification of shoulder-joint capsule after a trauma by Nowakowski, and others.

FIG. 14.—Case XI. Seven years after posterior dislocation of the elbow. Extensive ossification of the joint capsule and under the triceps tendons.

b. Myositis ossificans subsequent to dislocations develops most frequently after backward dislocation of the elbow, till 60 per cent. in brachialis interne muscles, according to Machol. Our Cases X, XI, XII, XIII, here included. It has been observed also as a rare complication of a supra-acromial dislo-

cation of the clavicle (Strauss), after luxation of the hip (Ewald), of the knee (Noble), and of the shoulder (Regnier).

c. Development of bone along the track of perforating gunshot wounds, when the projectile either did not injure the bone or only touched it.

d. Myositis ossificans after clean incised wounds. Its appearance after clean incised abdominal wall wounds at the white line following operations on the stomach is the commonest one and was described several times, by Roepke, Sabjakina, Capelle, Wollenberg, Nierenberg, Rokitanski, Strassberg, Rixford, Clairmont, Rubesch, Lecene, Painter, Clarke, Hannes, Coenen, Gruber, Borchi, Gallagher, Mebius, Lewis, Eiselsberg, Noble and others. This form, otherwise very rare, has been seen also after a suprapubic prostatectomy by Lewis, after a herniotomy by Jones, after puncture wounds by Bender, Werner, after incised wounds of the thigh by Cranwell, at the glutei by Schwarz.

FIG. 15.—Case the same as in Fig. 14.

2. *Myositis Ossificans Chronica.*—a. The bone formation occurs after repeated slight injuries. To this group belongs the "rider's bone" in abduction muscles, following steady irritation at horseback, the cavalryman bone at the outer side of the thigh from sabre hits (Ludwig, Binnie), the soldier's bone at the shoulder from rubbing with the rifle, etc. "Exerzierknochen" of the German authors at deltoid muscle and biceps, "Bajonettierknochen" at the pectoralis muscle, and "Turnknochen" in biceps muscle. The condition is very common in some armies, according to the method of training the soldiers. Hasse, for example, recorded 16 cases among 600 German soldiers, when Bowen could find only two in the U. S. A. Cavalry. To the above-named group belongs my Case XV.

b. Bone formation owing to occupational overstraining of some group of muscles, occurring among joiners, shoemakers (Haga and Fujimura). This group is demonstrated in Cases VIII, and to some degree I. The former

worked hard mending telegraph wires, the last was a joiner overstraining his thigh muscles with a lever. No history of a single severe injury could be elicited in both of them.

c. Myositis ossificans circumscribed, spontaneous, when even a single or repeated slight injury can be excluded, very rare, if existing at all.

3. *Myositis Ossificans of Infectious Origin.*—Ossification of muscles being a seat of a metastatic abscess, as described by Noble, Elmslie, Whitelock, after a pyæmic abscess or a phlegmon of the forearm as reported by Roskowski.

4. *Myositis Ossificans Para-arthritica.*—A form, so far as I could find, not described till now. Here belong my Cases I, IV, V, XIV. Bone formation in muscles and tendons occurs near to joints, ailing of a chronic inflammatory process, as arthritis deformans or tuberculosis. In none of these cases was any form of injury related. The cause was either the chronic inflammation in the neighborhood or the factor exciting the main disease.

FIG. 16.—Case XII. Ossification in the brachialis internus muscle after posterior dislocation of the elbow.

5. *Myositis Ossificans Neurotica* (Ostiasis, Steinert).—Development of ossification of muscles and tendons subsequent to tabes, syringomyelia (Ludloff, Tomaszewski), traumatic paraplegia (Israel, Zanoli, Geldmacher), and myelitis (Kuettner). Little disease (Horvath), located mostly in the upper arm muscles by patients suffering from syringomyelia, and in thigh muscles from other named diseases, very rare in calf and forearm, mostly multiple, being probably due to increased opportunity to injuries or to trophic changes.

Course.—The course of myositis ossificans traumatica is a typical one and can be divided into three stages. In the first typical traumatic symptoms are predominant. They subside within a few days, only limitation of movement,

improved somewhat with the ceasing of traumatic symptoms, does not disappear entirely. In the second stage at the end of the second week or later, according to the care and rest given to the damaged region, the pain, spontaneous and on movement, reappears, the impairment of motion increases and the circumscribed, somewhat not elastic, swelling becomes slowly larger. There are either no, or very little, symptoms of inflammation in this stage. Three to four weeks after the injury the Röntgen-ray examination reveals a faint shadow, irregularly and indistinctly limited, not homogeneous, with darker and lighter areas, situated parallel to the shadow of the bone of the skeleton, but separated from it by a light zone, present also in cases in which an attachment to bone is certain. There is a marked incongruence between the size of the palpable mass and its size in the X-ray picture, as in my Cases II, VI, VII.

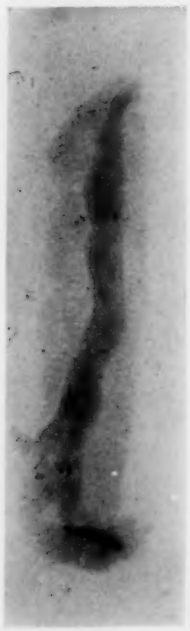

FIG. 17.—Case XVII. Bone formation in the laparotomy scar. X-ray photograph of the removed mass.

In the third stage the growth of the mass stops or the lump increases slowly by periosteal apposition. The pain disappears or remains unchanged. In X-ray pictures the shadow is more homogeneous, intense, sharply limited and at times smaller than before. The duration of the growths time of the mass is variable from ten weeks to six months.

As a rule there is no fever in the course of myositis ossificans. There are but few cases known in which were marked inflammatory symptoms, as in cases of Itzerot, Salmann and Peiser. There were also very rare cases in which the ossification developed some years after injury as in the case of Chaton and Caillods forty years after a trauma.

In other forms of myositis as myositis ossificans chronica ossification after laparotomy wounds, neither the patient nor the physician could determine precisely when the mass began to develop. In laparotomy scars the bone was found earliest at the end of the third week after the operation. Rider bone and similar forms appeared mostly after three to four months.

Pathology.—The parosteal bone may be different in form and size. There have been irregular masses of some cm. to plates occupying a part or even the whole of a muscle, surrounded usually by a strong connective-tissue capsule, periosteum-like, many cm. thick, grown together with the muscles, degenerated within the mass to some degree.

The mass was lying either separated from the shaft without any bony or connective-tissue attachment to it, or grown to the bone by a connective-tissue band, therefore but little movable, or by a bony pedicle attached to skeleton bone. The pedicle can be large or narrow, joining the mass to a bone of the skeleton at one end, or in the middle. It is not seen in the recent cases in the X-ray picture because it is still porous and without calcium deposits. It does appear when the callus is quite mature.

In some percentage of cases, according to Strauss, up to 10 per cent., the new bone contained a cyst filled with a light yellowish, sometimes reddened, synovia resembling fluid. The cysts were always placed at the lower extremity of the thigh, but in the case of Nimier the cyst was found in the brachialis internus muscle. Such cysts were reported by Rammstedt, Schultz, Vulpius, Wolter, Busse and Blecher, Zhuber Van Ohrog, Nimier, Strauss, Berndt and others.

FIG. 18.—Excessive two-week's old callus after fracture in a man, aged twenty.

The microscopical picture of myositis ossificans is very characteristic: there is an irregular mixture of bone, cartilage, muscles and connective tissue. The usually spongy bone forms variably shaped trabeculæ, surrounded by connective-tissue layers of differing amounts of inter-cellular substance and sometimes by mostly discontinuous rows of osteoblasts. The bone plates seemed to arise from the connective tissue either directly; the fibrous connective tissue beginning in some place to lose its structure becoming homogeneous and changing by deposition of calcium salts and converting the fibroblasts into bone cells without any distinct limit into osteoid or bone tissue; or indirectly, the bone trabeculæ arising from connective tissue by cartilage stage. The muscle, according to most writers, plays no active rôle in the whole process: it becomes compressed by newly formed connective tissue and undergoes degeneration. Busse and Blecher only assume that the muscle cells are converted into connective-tissue cells and then into bone. In later stage there are no signs of rapid growth, but contemporary to the resorption by giant cells the bone increases by periosteal or osteoblasts apposition at margins. In most instances no, or but small, signs of inflammatory nature were found. But according to Borchardt it is due to the late period of the process. In the early stage marked inflammatory reaction could be confirmed microscopically. It would be of interest to

remember that the same pictures and stages were seen, according to Lexer, also by the study of the progressive form of myositis ossificans, and, similarly and in the same period of time by callus formation after the fractures of long bones, as stated by Bancroft in his experimental work.

Diagnosis.—The diagnosis of a well-developed stage of ossifying myositis is not a difficult one and can be made with a high degree of certainty, but in the early period it requires great care. Many conditions giving a similar picture must be excluded, as a hæmatoma, muscle callus, muscle tumor, osteomyelitis, interstitial syphilitic process, periostitis, traumatic and infectious, fractures and neoplasms. The differentiation between a muscle callus and inflammatory infiltration of the muscle may be impossible even with X-ray examination. The traumatic exostosis, as described by Weber, Virchow, Volkmann, Luecke, Billroth, Pels-Nelsen, Delbet, vary but little from myositis ossificans and often a distinct limitation from each other can be very difficult even impossible at all, especially from quickly growing forms as reported by Honsell and Schuler, Sieur, Délorme, Cahen, Mollier, appearing within two weeks following injury as a large pedunculated mass located over the shaft of a bone, sometimes very tender. The only difference is then in the want of near relation to the muscles. My Case II corroborates the view of Oliver, Bowen and others, who assert that ossifying myositis and traumatic exostoses are identical.

Most important and sometimes very difficult may be a differentiation between a myositis ossificans and a sarcoma. Before Röntgen-rays were known, such fatal mistakes were common, and according to Finney reached to 50 per cent., and according to Bull even 75 per cent. Both conditions have many points alike: both develop in young persons after a trauma, grow quickly and are of hard consistency. The period of time passing from injury to the development of the mass can be also equal. Some authors as Strauss, Coley, maintain that the localization of the disease can be also of diagnostic value; sarcoma, for instance, is usually located near the epiphysis, while myositis takes place over the shaft. This affirmation seems to me unreliable. I have seen a sarcoma placed over the shaft of the femur, giving an X-ray picture exactly like to the Case VII of myositis by Lewis. But there are other differences: Steady growth of the mass and infiltration of soft parts, late spontaneous pain with tendency to increase, unequal consistency by palpation are signs of a sarcoma. Inclination to shrink and diminution of the swelling of soft parts, early pain, lessening slowly in severity, equal hard consistency to touch are symptoms of myositis ossificans, emphasized by many authors (Noble, Coley, Bloodgood), leading considerably to right diagnosis. The most significance attaches to the X-ray examination. In myositis the cortex of bone and periosteal line are even and unchanged, the new-formed mass gives a shadow parallel to the margin of the cortex separated from it by a light zone, as it is evident in my Cases II, VII, IX. In sarcoma there are very early medullary changes and destruction of cortex, the bony mass trabeculæ running obliquely or transversally to the shaft and

are visibly connected with it (Lewis, Coley), when the diagnosis remains still doubtful exploratory incision is indicated. It can be, however, not decisive, as advocated by Bloodgood and confirmed through the case of Paul.

Complications.—The complications vary with the seat of the mass. Located over the shaft they cause usually slight discomfort and limitation of motion as in most of my cases. Placed over or near the joints, they interfere sometimes considerably with the function of the extremity. Most common are such complications after posterior dislocation of the elbow where often but traces of motion are present, as in Cases X, XI, or the joint is entirely stiff. Similar was seen in other joints: In hip-joint in case of Graf, in shoulder-joint in case of Nowakowski and others.

Complications such as in my Case VII, where the lesion was followed not only by spontaneous pain and limitation of motion at the elbow, but also of the hand and fingers, as a sequel of paresis of the radial nerve, are not common. Similar cases were reported by Délorme and Yvert: a parosteal callus after posterior dislocation of the elbow compressed the brachial artery and the median nerve with circulatory disturbances and paresis. According to de Witt thrombosis of popliteal artery, and in case of Koester, a gangrene of the foot developed in consequence of a parosteal bone formation at the popliteal fossa. Twice a transition of a myositis into sarcoma was observed by Da Costa and Coley. By the last six years after an injury and three years after a microscopically ascertained myositis. The case of Paul is not distinct enough.

Anatomic Distribution.—To the development of a parosteal bone some regions are particularly disposed. Specially where the bone is covered with a thick layer of muscle, where the last insert broadly into the periosteum and near to joints, as on the thigh anteriorly and sideward, as the quadriceps and adductor muscles, and on the arm, the brachialis internus and triceps muscles. In Rammstedt's statistics dealing with 14 cases, 11 occurred in the thigh muscles, 2 in the upper arm, 1 in the gluteal muscle. Strauss found among 127 cases, 43 in the quadriceps, 13 in the adductor muscle, 64 in the flexor muscles of the upper arm, 2 in the masseter, 2 in the gluteal muscles, 1 in the muscles of the ball of the thumb, and 1 in the temporal muscle. According to Jones, who named 339 cases, the brachialis internus, adductor, and biceps brachii muscles are the most frequently affected.

In my material, 5 occurred in thigh, 8 in upper arm muscles, 1 in a laparotomy scar. It is surprising that myositis does not affect the regions most frequently exposed to an injury as the lower leg or forearm in which there is an easy occasion to periosteal lesion. Its appearance in these regions was noted in some rare instances, as by Chaton and Caillods in leg, by Whitelocke in soleus muscle, by Noble in flexor carpi muscle, by Salmann and Peisser in iliopsoas muscle and by Roskowski in the forearm muscles.

Age.—In most instances myositis ossificans developed, according to Noble, Strauss and others, in middle life, between 15 and 25 years. In Strauss' statistics the youngest patient was 12, the oldest 50 years of age. Fay has seen

myositis in a boy 5 years old and in a man 57 years old, and Graf, Weinlechner, and Lewis in 70-year-old men.

In my cases 7 were under 25 years old, and 10 over 25, and between them 3 over 60 years old. If we put the cases after posterior dislocation of elbow separate, there were 4 cases under and 9 over 25 years old.

Treatment.—In early times when myositis ossificans was insufficiently known and especially when it was often mistaken for a neoplasm, it was treated by radical operative measures, regardless of the stage of its development. Helferich advised to treat it as a malignant tumor by excision in healthy parts; Schuler, Règal and others, were for an operation if the mass increases; Délorme advised sparing extirpation, and Lapouette favored excision after six to eight weeks from the beginning of the disease. On the contrary, most of to-day's surgeons recommend conservative treatment, in the early stage of the process especially, and even in later periods they are for to "leave it alone," unless it interferes with the function; for myositis has the tendency to shrink or even disappears completely without any interference, as reported by Wendt, Vollhardt, Rovley, Strauss, Bristow, Thiemann, Wichmann, Rassmussen, Délorme, Lelasque, Schultz, Nadler and others. The early operations were often followed by recurrences, mostly, however, in cases of broad attachment to the bone of the skeleton (Blecher, Rotschild, Berndt, Schultz, Strauss, Painter, Morley), my Case VII. At the early stage of the disease it is very difficult to deal with tissues changed in outlook and anatomical position, inhibited with blood, therefore with tendency to become infected. One must also consider that inflicting another injury to parts inclined in that period to ossification, one may renew the activity of the morbid process (Wilms, Guleke, Godlee).

Early operation can be indicated in such cases as my Case VII, regardless of the possible recurrence, when waiting can result in an irreparable damage of the function of the extremity; however, there are few cases where a strictly conservative treatment was followed by recovery (Délorme). In my case appeared a small recurrence at the upper end of the incision, which was not disturbing, and there was no cause to regret having done an early excision of the mass.

In most cases a simple excision of a mass, being stationary, as advocated by many authors, is sufficient to bring recovery. Morley, in agreement with his explanation of genesis of myositis, advised excision combined with grafting of the deep fascia on the denuded bone surface. In my case, however, as reported above, the periosteum was curetted away, where it was covered with the mass; the recurrence did not develop there, but above, where the periosteum was not removed.

The conservative treatment must conform with the stage of the process and the region in which it developed. According to Noble, in the period of traumatic symptoms in a region inclined to development of myositis ossificans, prophylaxis is most important: the damaged region must be kept in rest. Where a reposition of a displaced joint must be made, it should be done with

a minimum of trauma. Briefly: "In the first stage reduce the trauma to minimum." Shere advised aspiration of the hæmatoma or even an incision and drainage. In the stage of bone development and growth also rest is essential, for even slight traumata, as massage and slight movement, were sufficient to raise the activity of the morbid process, as confirmed by cases of Rotschild, Berndt, Busse and Blecher, Nowakowski. There are but few cases reported in the literature, when the extremity was in rest during the critical days, as cases of Borchardt and Ellbogen, and the bony mass developed nevertheless. Undoubtedly early movement influences the size of the mass.

When the mass becomes stationary or begins to decrease, energetic osteopathic treatment is to be employed.

Among other measures X-ray therapy was tried by Neri, fibrolysine injections by Grosskurth, and injections of pepsin solutions by Karell.

Etiology.—The question, why myositis ossificans occurs relatively so rarely in comparison with the frequency of injuries, why it tends to develop in some particular regions and not in the most frequently injured, as the lower leg, from where does develop the new-formed bone, are not solved sufficiently till now.

A number of theories have been advanced to explain the genesis of myositis ossificans. They all could be divided in two groups: the one assumes parosteal bones are arising from the periosteum of the neighboring bone, the other advances a metaplasia of local connective tissue.

The theory of periosteal origin of parosteal bone, initiated by the works of Ollier, by experimental studies of Bertier, advanced by Berndt, Sudeck, Pochhammer and others, advocated by many authors as Rassmussen, Délorme, Berger, Sieur, Schulz, Berndt, Lewis, Lyot, Finney, Jones, Bode, Louis, Roepke and many others, is based upon clinical observation; there are many cases of myositis where the attachment of the bony mass to a skeleton bone was proved both clinically and at the operation. Also the Röntgen-ray investigation of Keinboeck, Kalb, Haberling and others, seemed to confirm this idea.

The parosteal bone formation may be accomplished by many ways: Berndt believes that a severe blow crushes the muscles into a pulp and injures the periosteum opposite to it. The osteoblastic layers of the periosteum proliferates then, the osteoblasts escape into the crushed area of muscle and there form a bone.

Lyot's theory, according to Bowen, is: "A muscle is in action, receives a blow, some of its fibres tear themselves from their bony origin and retracting into the mass of muscle still connected with the bone, carry with them particles of periosteum. These particles grow in their new environment, are true bone grafts, and can form intramuscular osteomata, unconnected with, though originating from the periosteum."

Morley's theory is described by Bowen as follows: "A severe blunt injury at once subcutaneously strips off and destroys the periosteum and crushes the muscles in contact with the bone. Bleeding occurs from the sur-

face of the denuded bone and with the blood osteoblasts, in a free and possibly ameboid condition, escape into the pulped muscle tissue and blood and there produce a growth of bone. Healthy muscles left in contact with denuded bone form protective fibrous adhesions from their interstitial connective tissue and take on the limiting function of the periosteum. But severely contused muscle tissue mixed with blood provides a favorable pabulum for an osteoblast."

The importance of a hæmatoma was also advocated by Schultz, Délorme, Vulpius, Duems, Sudeck and others. Pochhammer tried to confirm it experimentally. He formed a pocket from pedunculated periosteum flaps on rabbits, filling it with coagulated blood, and was able to state that bone developed only in spaces filled with blood clots. When the growing new bone comes in contact with healthy tissues it stops. The shape and size of the ossification are dependent therefore upon the form and size of a hæmatoma. It remained to confirm whether the periosteal stripping by a trauma really occurs and if the periosteum retains in such conditions its osteoblastic power. Sudeck attempted to solve the first question with regard to the posterior dislocations of the elbow. He found in experiment performed on cadavers, that in backward dislocations of the elbow, the injury of the capsule and periosteal stripping occurs almost constantly, usually at four points: over the posterior surface of the humerus, above the olecranon fossa, above the supratrochlear fossa, and over both condyles. Marcus and Galey, however, quoted by Strauss, state that immense force is necessary to detach the muscles from the bone. Koenig and Berndt believe it also to be impossible: it is easier to break off a piece of bone than to detach the muscle from the bone. Kuettner, Lexer, Strauss, Stone (the last quoted by Bowen), observing the fact that myositis occurs in muscles attached broadly to bone without a distinct tendon, are of opinion that it is easier to detach such muscles than those with a strong tendon. The idea of an anatomical disposition of a region to bone formation is thus originated. Machol, studying posterior dislocations of the elbow, found in 60 per cent. development of bone there, being due not to the trauma of dislocation itself, but of the reposition. I have repeated the experiments of Sudeck on cadavers and found that the stripping of periosteum occurs most markedly over the anterior aspect of the coronoid process of the ulna and over the posterior surface of the humerus. In a minor degree anteriorly above the supratrochlear fossa. The joint capsule passes into the periosteum without distinct limits and after stripping of the joint capsule at its margin, the periosteum detaches from the cortex easily. Microscopically, however, the torn off periosteum contained no osteoblastic layer. By reduction the torn off periosteum becomes more or less accurately replaced and does not cause a parosteal ossification. By unreduced dislocations the parosteal bone formation reaches sometimes an excessive amount as in my Cases X and XI.

The first question can be answered therefore that after dislocations the stripping of periosteum is a sure and almost common appearance. Whether

it occurs also by injury over the shaft remains in question. I was not able to produce it on cadavers of adult dogs, even when the periosteum about the muscle attachment was cut.

In regard to the other question of the osteoblastic power of the transplanted periosteum, it would be necessary to recall some facts. The question was studied by Barth, Marchand, Saltykow, Lexer, Laewen, Lobenhoffer, Frangenheim, Radzimowski, Sultan and many others. Berthier detached flaps of periosteum at the muscular insertion and stimulated the muscles electrically. He found in a period of time up to four months only in some of the rabbits bone formation in muscle. Grohé has seen in a free transplanted periosteal graft, traces of proliferation. After Schepelmann a free transplanted periosteal graft can produce bone, but very limited in size and disappearing after a time.

Martin, Tsunoda, Nakahara, Dilger, and Jokoi were able to demonstrate that the periosteum connected with a plate of cortex forms a new bone. A mass curetted from the cambium layer produces no bone, contrary to the opinion of Ollier.

Dawis and Hunnicut, quoted by Bowen, on the basis of their experimental study, came to conclusions: "Periosteal transplants in the majority of cases do not produce bone; pedunculated flaps of periosteum produce no bone, except for the pedicle connecting them with the bone, free periosteal flaps and pedunculated flaps with bone shavings attached produce bone in ever, instance."

Murphy came to similar conclusions. Baetzner found no bone formation in 47 transplantations of free periosteal flaps in grown-up animals among 15, in young dogs only once. Riess believes that in young dogs till nine months, periosteum detaches easily from bone with the osteoblast layer and is able to produce bone.

Lexer and his school made extensive experimental studies on this subject and states that free transplanted periosteal flaps in normal conditions produce no bone, for free transplanted periosteal grafts produce bone only when detached with the osteoblast layer, which is only possible if irritated and showing a proliferation of osteoblasts. To produce a proliferation in experiment is a very difficult matter. Bone production succeeds when periosteum was transplanted with a plate of cortex. According to Koch periosteum of grown-up animals can produce bone if there are osteoblasts on it and when blood-vessels are not cut. The new-formed bone disappears soon, when there is no function for it. Martin, Rode, Willich came to similar conclusions.

Some differences between the results obtained by several authors are due to different methods employed and to the fact that several sorts of animals were used. As is well known, rabbits incline very much to excessive callus formation, while cats occupy the diamethrally opposite position. Dogs show a tendency equal to man.

Summing up all above said, one must come to the conclusion that periosteal grafts, free or even connected with muscles, produce bone inconstantly

and only in young individuals in the period of growth. In adults only if it was torn off in the stage of proliferation of osteoblasts, if inflamed or if taken off with a piece of cortex. In the last instance the new bone grows very slowly and disappears after a time. Such conditions are undoubtedly very uncommon in myositis, for it occurs almost exclusively in individuals of middle age and my cases 41 per cent. were above 40 years and 17.6 per cent. over 60 years old. For young individuals under 20 years of age myositis is very seldom, as compared with the opportunity to injury. This suggests that the periosteal theory in its present form is not sufficient to explain the development of parosteal bone after a single injury. If it arises from periosteum, other conditions accompanying are necessary, not repeated till now in experiment.

The other group of theories assume parosteal bone to result from a metaplasia of connective tissue.

The theory initiated by Orth is based also upon clinical observation: In most cases of myositis ossificans no connection was found with a skeletal bone even of fibrous tissue. The microscopical finding seems also in many cases to indicate that the connective-tissue cells are converting into bone and cartilage cells. The X-ray examination reveals almost constantly bone formation in large spaces with many points of ossification, a form uncommon to the periosteal ossification.

The existence of metaplasia is well known to pathologists. Metaplastic bone formation has been seen in almost every part of the human body, as in heart-valvulæ, lung, skin, brain, liver, in arteries, glands, etc. (Borst). The connective-tissue cells convert into bone either directly: calcium salts depositing in intercellular substance and connective-tissue cells becoming bone cells, or indirectly by progressive metaplasia (Virchow), connective-tissue cells transforming into cartilage, respectively, bone cells at first and produce then a bone.

There is also no obstacle to assume the ability of connective tissue to convert into bone. The connective-tissue, cartilage and bone genetically arise from the same embryonic layer-mesoblast and transform later into each other. According to Wolter the only difference between all kinds of tissues developing from mesoderm lies in the difference in their intercellular substance and is not sharp. They all react to an injury with formation of a new tissue accommodated to new conditions. The connective tissue incline above all more to a hyperproduction than to a specific regeneration. It refers especially to the intramuscular tissue and tendons.

Koester enrolls the intramuscular connective tissue to tissues of the bearing apparatus (Stuetzgewebe) and assumes that the limit between them may be peripherally displaced: the connective tissue of the muscles, fascia, tendons and ligaments become thus endowed with powers usually belonging only to the periosteum (Ziegler quoted by Bowen) or show a character of a periosteum (Ribbert). Such conditions are to be found in the progressive form of myositis ossificans (Lexer). Osteoblasts may arise from periosteum as well

as from connective tissue (Kawashima, Kaufmann, Bancroft). There may be also an incomplete differentiation between the tissues descending from mesoblast (Stempel, Juengling, Frattin, Blencke).

Metaplasia is not an usual appearance. There remained to establish the conditions under which it may occur. Many writers called attention to calcium salts. Pollack found in 17 per cent. of necropsies bone in lung glands besides calcium deposits. Cohn, Rosenstein, Rohner, Menckeberg, described also occurrence of bone in artery walls in 8 per cent. of old men. Barth, Poszaryski, Sacerdotti and Frattin, Roepke, have also seen true bone in calcified glands. Liek made extensive experimental investigations on kidneys of rabbits and came to the conclusion that a bone develops always where a young connective tissue adjoins a calcified one. Bone formation follows therefore a necrosis and calcification. Roepke supposes that while an injured extremity is resting, the bone becomes decalcified, calcium salts being precipitated into the crushed muscles, causing a metaplastic bone formation. Pochhammer and Schujeninow also state that calcium deposits are common in fresh laparotomy wounds, but disappear early. Gruber believes therefore that the local deposits of calcium have no influence in parosteal bone function. The "distrophic bone" is a process different from myositis ossificans. It requires a much longer period of time up to several months or even years and follows to a necrosis of tissues. In no case of myositis ossificans calcium deposits were found. Also Rode restudying recently the rôle of calcium salts to bone formation in muscle, concluded that calcium locally given has no influence to metaplasia of normal connective tissue.

Mebius, Gruber, Dibbelt and also Christophe suppose, that an increased amount of calcium salts in blood serum plays an important rôle in the appearance of metaplasia. In my two cases among the three examined, the calcium salts content of blood was markedly increased. They are submitted to the intern secretion of parathyroid corpuscles. With an increase of their function the calcium salts content of blood rises (Jerome, Reuss). It rises also if through some cause skeleton bone atrophies. If the elimination of calcium by the kidneys is abnormally limited, the salts become deposited in soft parts. It may be that they, acting upon the central nervous system, and on the other hand, upon the neuromuscular apparatus, cause a tendency to bony metaplasia of the damaged and inflamed tissues.

Among many other factors suggested to cause a metaplasia is to mention the synovia. Eden, stating that the most privileged regions to development of myositis ossificans are those near joints and the joint capsule was often grown together with the mass, attributed a very significant rôle to the synovia. Pau, Schwenck, Frangenheim, Grashey, Nowakowski have seen ossification of joint capsule. Some authors have found within the ossified mass a cyst filled with a synovia-like fluid. In cases of Schweck, Ludloff, Levy, a communication between such a cyst and a joint cavity was evident. Ewald summing up his anatomical studies was able to record, that every one of the joints being in question has special muscles or muscle

bundles straining the joint capsule. He favored the assumption of Eden that the named muscles convert into bone when injured under influence of synovia fluid escaping from an opened joint capsule or that the synovia itself may be organized and ossify. Ewald, however, was not able to prove his theory experimentally.

Berndt is of opinion that to slight hæmatogenous infection is due the development of parosteal bone formation because in some cases, operated upon, there was slight rise in temperature. In the initial course in some instances there were marked inflammatory symptoms (Salmann, Peiser, Itzerot) or ossification followed upon metastatic abscesses or phlegmon (Roskowski, De Witt, Noble). Dor found in a parosteal mass a micro-organism, which injected, occasioned a periostitis albuminosa or a suppurating osteitis with hyperostitis and exostosis formation. Lewis also believes some cases of myositis to be undoubtedly secondary to some infectious process in the muscle. I have the impression that in my Case XV the changes were due to a microörganism similar to those of a chronic osteomyelitis. Case XVI is also undoubtedly of infectious origin. Seydeler, quoted by Carey, Haga and Fujimura, held that hemorrhagic blood may organize and transform into cartilage and bone. After Holzknecht myositis is a physiologic reparative process agreeing to Wolff's transformations law that connective tissue tends to strengthen the statics apparatus, if it be damaged somewhat.

Schuhardt and Rathke explain the genesis of myositis ossificans by means of the histomechanic theory of Roux. In every place, where the tissues are submitted to pulling and rubbing, arise cartilage cells. They transform into bone by want of rubbing. Le Clerc attributes great importance to uric acid diathesis. The next factors assumed to cause a metaplasia are trophic or sensitive changes (Eichhorst, Klemm, Wilms and many others). The theory is based on the appearance of parosteal bone following some spinal troubles, as syringomyelia, tabes, myelitis, paraplegia, Little's disease and others, after lesions of motor centres exclusively, myositis ossificans was, as far as I could find, not observed. The adherents of periosteal theory believe the sensitive disturbances are of greatest importance: Ataxis, muscle hypotonia and sensitive disturbances are due to uncoördinated muscle contractions and excessive movement, giving occasion enough to stripping of periosteum (Morgenthal, Assmann). Accordingly it may be said that generally the articular changes are a later appearance than myositis. With syringomyelia there is no ataxia or muscle hypotonia.

Neurotrophic changes are held by others (Leyden, Goldscheider) as predominant factors causing a metaplasia. It may be that the want of checking influence of nerves plays an important rôle; the tissues lose their normal relation to each other.

According to Zanoli the main factors are intoxications and infections. The toxins act as irritants upon tissues, being in a state of less resistance. The decalcifications common in paraplegics, accompanied by circulatory disturbances, help to calcium salts deposits. But since also in presence of spinal

trouble myositis ossificans is relatively rare, there must be another cause, possibly congenital.

The etiology of bone formation occurring in clean incised wounds of the abdomen wall is also an open question. Some believe that there also a periosteal stripping is possible. Others assume a sort of predisposition: the lineæ transversæ are the remains of a rib and the white line a prolongation of the sternum. For this reason they contain sometimes osteogenic elements developing when injured, bone formation. Others assume a pure metaplasia on the basis of microscopical pictures, showing a marked transition of the connective tissue to bone with signs of inflammation (Mebius), under the influence of a hæmatoma (Vulpius, Roepke), or effect of acid gastric secretion (Noble, Hering, Lewis), or acid urine (Lewis), for in most instances a myositis ossificans in the abdominal wall developed after operations on the stomach. Concerningly it must be stated that during the performance of a stomach resection or a gastro-enterostomy, gastric juice has no opportunity to come in contact with the abdominal wall. Most of the wounds healed rapidly. Also performing other experiments, I have injected many hundred times acid-pepsine solutions into the scar and normal tissues of several regions of the body of man and dog and have never seen a trace of bone formation.

In Case XVII an injury of periosteum, as well as contact with gastric juice, can be excluded. The wound healed by primary intention. Only a tendency of the region to transform into bone with addition of trauma of operation may explain its appearance.

Among other explanations may be mentioned the combined periosteal and metaplastic theory of Frangenheim, Koenig, and others. According to it parosteal bone arises from both tissues, from periosteum as well as from connective tissue. Busse and Blecher assume that both species of tissues work separately: the main mass appears within muscles and then grows together with the mass formed by periosteum, contrary to Berndt and Virchow, who are of opinion that the continuity between misplaced intramuscular bone and the skeleton dissolve secondarily. The confirmation of this theory should be, according to Berndt, recurrences connected with the shaft, following often early operations of myositis. There is, however, to add that recurrences followed chiefly when the primary mass was connected with the shaft by a bony pedicle and not when lying free within muscles. The recurrence may arise from periosteum being inflamed in a region near the primary inflammatory focus. On the other hand, the experimental studies of some writers, the school of Lexer especially, have found connective tissue is antagonistic to the periosteum: fracture does not heal, when connective tissue has grown between the fracture ends. Last it may be mentioned, that myositis, as a rule, develops mostly in the upper and lower third of the femur and the lower end of humerus; regions often a seat of exuberant callus formation after fractures and of neoplasmic fracture complications (Frangen-

heim, my Fig. 16). We never meet with in bones lying superficially as for example the tibia. (Frangenheim.)

Some authors (Werner, Frank, Berndt, Lewis) assume for several cases several geneses.

Any explanation must be more or less hypothetic until it has become possible to produce these parosteal bones experimentally and constantly, says Fay, quoted by Bowen. It has proved, however, unsuccessful up to date, omitting some single observations of some authors (Berthier, Barth, Gruber, Haga and Fujimura), though much experimental work has been done upon this subject.

Marchand and Coton have used synthetic bone, Eden calcium salts intramuscularly without effect. Barth, Morpurgo, Baschkirzew, Petrow and Pochhammer implanted bone ashes, and Sultan, Axhausen, Baschkirzew, Petrow, Regard a boiled bone without success. Cristophe, however, transplanting in alcohol fixed bone, believes that by way of metaplasia of connective tissue it may become a living bone. To the same conclusion came Ely. Gruber could state no influence of calcium salts to bone formation within muscle.

Rohde made extensive experimental studies upon metaplasia and favors the assumption that we are dealing with undifferentiated cells, having a tendency to transform. A well-developed connective tissue is not able to convert into bone, even under the influence of calcium salts, either boiled or dead unboiled bone. He says, one never meets with a parosteal bone formation in the neighborhood of pathologic destruction of a living bone.

Lexer is of the opinion that metaplasia may develop in any part of the human body under the influence of an injury or an inflammation, accompanied by increased amount of calcium salts within the blood. The last cause, however, is unknown. The inclination of different parts to ossify is variable. A subperiosteal hæmatoma may be followed by a scar formation, when an epidural by bone. In tendon sheaths a hæmatoma ends with a scar and a hæmarthros may cause a fibrous or bony ankylosis for synovia membrane has near relationship to periosteum. Intra-articular fractures heal often by a bony ankylosis.

Hoffmann believes that connective tissue can transform into bone and fibroblasts can become osteoblasts.

Bancroft, studying bone repair, advances also the theory that " the so-called osteoblasts have very little to do with bone production. Calcium salts are deposited in the extracellular elements of connective tissue. The fibroblast then becomes a bone cell. Undoubtedly the periosteum with its areolar tissue and numerous small blood-vessels is the best structure for bone formation, but is not the only one."

Partsch found in some cases evident callus formation in connective tissue.

Aschoff attributes a great significance to the recticulo-endothelial apparatus in metaplastic bone formation.

To form my own judgment upon this subject, I performed thirty experiments on dogs, young and adult.

1. In the first series I have transplanted grafts of periosteum, free or pedunculated, between the muscles, sound or crushed with a knife, or a forceps, with addition of a hæmatoma or coagulated blood clot.

2. In the second series the same experiments repeated with administration of calcium salts by mouth, intravenously, subcutaneously or close to the transplanted periosteum or crushed muscle, with or without addition of a hemorrhage.

3. In the third series a joint fistula of a knee-joint was made to a periosteal flap, free or pedunculated, or to a crushed muscle, with or without calcium administration by ways as above. The muscles near to the fistula were healthy or crushed, with or without hemorrhage or blood clot addition.

4. In the fourth series parathyroidal corpuscles from a young dog were implanted between the muscles, calcium salts being administered subcutaneously at the same time and a pedunculated periosteal graft was implanted into the crushed muscles; or the muscle substance or their insertion to bone was crushed.

5. In the fifth series, in one dog the femoralis and obturatorius nerves were cut and then a periosteal flap with muscle attachment on the anterior surface of the lower end of the femur was embedded in the rectus muscle, crushed with forceps and a joint fistula was made to the crushed muscle. In another dog showing a paresis of the both hind legs, a joint fistula was made to a crushed muscle, to a pedunculated periosteal flap and to a crushed muscle attachment.

Technic.—Periosteum was torn off in every instance with a sharp instrument (raspatorium). Muscles were crushed with a forceps or a knife. Fresh blood clots were used from the same animal. That the joint remained open for a time (three weeks) was proved by cyst formation in the damaged soft parts. Intravenously calcium chloride solution, 10 per cent., was used every other day, three weeks long. Subcutaneously calcium phosphoric suspension was given for the same period of time. The parathyroid corpuscles were taken from dogs of equal weight and age (four months). The dogs were not kept in a cage, but ran freely in a room. The dogs were then examined every third week by X-ray, by palpation, in a number of experiments by exploratory incision and then all by necropsy. The observation time lasted from three weeks to four and a half months.

Results.—The results obtained are as follows: Free transplanted periosteum grafts formed bone in no instance. In no case also did any bony mass develop within muscles being crushed, or at their damaged insertion to the periosteum, pedunculated periosteal grafts formed only a small exostosis at the basis of their pedicle. A periosteal transplant with a plate of cortex showed extensive growth in no instance, neither transplanted free nor with muscle attachment. The transplanted plate disappeared within some weeks.

These experiments do not explain whether the parosteal bone may descend from periosteum or from connective tissue. But if any conclusion can be formed from experiments on animals to that of man, I must conclude, that the foregoing experiments failed totally to confirm the theories, referring to genesis of myositis ossificans illustrated by the above experiments. They seem to suggest that all the factors assumed as playing a rôle in parosteal bone development as a hæmatoma, synovia, calcium salts, nerve disturbances, in presence of periosteal stripping or muscle crushing, are not able to produce it alone or combined. Assumption of an additional, maybe, congenital factor, seems to me unavoidable.

The want of success in these experimental studies and the difficulty of explaining all cases of myositis ossificans by any of the theories has caused most investigators to come to the opinion, there must be a congenital factor in it. According to the constitutional theory, called by Virchow, Koester, Recklinghausen and others, a diathesis ossificans, there is a particular congenital tendency of some particular regions of body to react to injury with metaplasia of connective tissue to bone. The connective tissue, stopped at some point of incomplete differentiation, tending under some conditions to proceed to later stages of the development (Van Der Briele, Rhode, Stempel, Cahen, Bard and others), or young connective tissue has the ability to assume the character of an embryonic tissue with its normal course of changes (Graf, Vulpius, Schmidt). An easy vulnerability of bony system and inclination to produce (Pinkus). Here belongs also the theory of aberrant sesamoid bones of Bard, Painter, Marshall, Ziegler, Bowen, Binnie, Knaak, De Witt, Villaret, Hein and others, authors of last date, who imagined the genesis of myositis ossificans to be as follows:

There is a congenital dyscrasia or diathesis of various degree. Individuals in the first group have the greatest tendency to bony transformation and develop the progressive type of the disease early in life. The other group inclines to form circumscribed bony masses after repeated slight injuries, while those in the third group with a less dominant diathesis require a very severe trauma to produce bone in muscle.

Painter believes that this is the only pathogenetic theory which will cover all cases.

Some facts, as several times reported, cases of parosteal callus formation, developing multiple, either soon after a single severe injury (Busse and Blecher, Berndt, Carey), or within a longer period of time after another severe injury in the same or other region, or after repeated slight injuries multiple (by Knaak between 28 rider bones there were 6 bilateral), favor considerably the theory of congenital tendency to parosteal ossification. A certain number of such cases was observed by Schultz, Haga and Fujimura, Busse and Blecher, Cordijjot, Katz, Délorme, Sieur, Koester, Labrevoit, Eichhorst, Wilms, Schlesinger and others. The most of them were, however, accompanied by changes of the medulla spinalis.

The congenital theory does, however, not explain the regularity of parosteal bone formation after posterior dislocation of the elbow. Possibly in these there act different factors. At first the periosteal stripping or a local tendency to ossification of the region in question.

The relative rarity of development of myositis ossificans in young individuals speaks also against the theory of Painter.

Pathological Classification.—The opinion of authors vary considerably regarding the nature of myositis ossificans. Some of them, as Cahen, Van Der Briele, Ziegler, Honsell, believe, referring to its traumatic origin, to the irregular mixture of tissues in its composition, its uselessness for the organism, that it is a neoplasm, though instead of characteristic properties

of a tumor, namely limitless growths, myositis ossificans has the tendency to shrink.

On the other hand Berndt, Borchardt, Haga and Fujimura, Delbet, Pels-Nelson and others, assume an inflammatory reconstructive process on the ground of the microscopical picture, which showed in several instances marked inflammatory signs, of its clinical symptoms, including in the very beginning those of a local inflammation, swelling, tenderness, impairment of motion, of its tendency to diminish or to grow worse, if early moved. Connective tissue and, especially, young granulations tissue, ossify; the inflammation prepares the ossification (Mebius).

The last group of writers are of opinion, that myositis ossificans takes a middle place between an inflammatory process and a neoplasm, (Virchow, Wolter, Helferich, Lexer, Salmann, Bremig), or that it is a sui generis disease of muscle. I believe we are dealing here with a reparative process, originated by an inflammation in the connective tissue.

Discussion.—My cases regarding the etiology could be divided into certain groups: In Cases II, III, VI, VII, IX, and in some degree XIV, parosteal bone formations, occurred in consequence to a single, more or less severe, injury. The traumatic symptoms were in all approximately identical. In Cases II, VI, VII, the lump was apparently attached to the shaft and its derivation from periosteum is probable. Such cases may be called periostitis ossificans as distinguished by some authors (Bloodgood). There is no ossification of a detached periosteal flap, but an inflammatory proliferative process on the periosteum of the shaft itself or of the periperiosteal tissues.

In Case III injury of periosteum is improbable. The new-formed bone lying in the quadriceps tendon was separated from the shaft of femur by the subquadricipital bursa, the last or the tendon tissue being likely the source of ossification.

In Case IX an injury to the periosteum is possible. There were apparent inflammatory symptoms at the olecranon. It is difficult, however, to explain the mechanism of displacement of avulsed parts of periosteum, as the triceps tendon is a very strong and compact one and an injury causes easier a fracture of olecranon than a tendon tear. There seems to be a bony metaplasia of soft parts near the inflamed skeletal bone.

Also Case XIV offers no argument for assumption of periosteal origin of bone formation within the coracoacromial ligament. As stated by Lexer's school, there is an antagonism between the periosteal bone formation and healthy connective tissue. A periosteal bone formation could in no way replace a ligament in a manner, leaving its shape regular and even and apparently homogeneous. The ossification is probably due to the elements of the ligament itself. This case belongs therefore to the group 3.

2. The traumatic cases after backward dislocation of elbow are probably genetically different from those mentioned above. They form a very common or even usual complication of this lesion. The periosteal stripping in this condition is an established fact. The assumption, therefore, that the adven-

titial bone descends from periosteum, is based on sound principles. The ossification begins, as evident in Case X, on the shaft of the humerus and the anterior aspect of the coronoid process, as also in other places near the bone. But there also the periosteum is not the only matrix of ossification for, as it can be seen in X-ray picture and microscopical sections, the joint capsule if injured is equally a seat of the process. The ossification seems to occur in the external layers of the membrane. But as the appearance in other joints is not a usual and steady one, one can conclude that the connective tissue neighboring to some joints and to the elbow-joint especially, and firstly the joint membrane, being maybe insufficiently differentiated, tends to transform into bone, when injured or inflamed. The traumatic inflammation is probably a factor of greatest importance. The cases suggest to have no other disposition to metaplasia than a local one.

3. The Cases I, IV, V, XIV, are the most remarkable. The parosteal bone appeared in consequence or parallel to a chronic joint disease. The joint symptoms in Case I were covered by those of the mass before removal of the last, but undoubtedly were existing as the primary condition. In this case a periosteal stripping, either from the femur or from the iliac bone, is very improbable. One could indeed imagine the fluid distending the joint capsule was able to tear it off at some point of its margin and with it a periosteal flap, being inflamed and consecutively more loose, but it is impossible to understand the detachment of a periosteal flap at its whole circumference and its displacement into the muscle. Still more improbable appears the descending of the plate from the iliac bone, though the mass was connected with it by a scar pedicle. The new bone was grown strongly with the joint capsule forming a sort of a stalactitic process directed downward. The impression is that the inflammation extended to the near tissues, causing their bony metaplasia. It is impossible to decide what has given a disposition to it, whether calcium salts or any other factor.

Similar to it in Cases IV, V, XIV, there is also a combination of chronic joint changes with an ossification in the neighborhood. All cases but one (IV) concern the old-aged individuals, suffering from deforming arthritic process. Ossification in old age is to some degree physiologic and a rather common appearance. It is also characteristic to deforming arthritis, that there are almost constantly deforming exostotic bone changes at the margins of joints (Struempel). Similar condition is given in Case I of Bowen, where there were also chronic joint changes at the knee and ossification occurred, though far from it, in an injured region. Excessive ossifications close to joint are also essential in the neurotic form of myositis ossificans. There could be two possibilities: Either the development of a deforming arthritis, even of a single joint, is based on a congenital or acquired tendency and the bone formation, near the diseased joint, is a consequence of inflammatory changes of the involved tissues, probably tending to ossification as a physiologic appearance of old age or under the influence of the product of inflammation; or the deforming arthritis as well as the tendency to ossify or to development of

exostosis are all together depending upon a diathesis without any relation to each other.

Case IV requires a separate discussion. Ossification developed in a young girl in connection with a tuberculous arthritis. Such combinations were already reported sometimes *e.g.*, by Kaufmann in consequence to a tuberculous spondylitis. There are but few arguments to assume a periosteal bone formation. More intercede for a metaplasis. This case would lead to similar conclusions as the cases above: The chronic joint changes are able to cause a metaplasia itself, although a part of the ossification could undoubtedly originate from periosteum.

4. Cases VIII, XV, belong to the so called myositis ossificans chronica. In Case VIII ossification developed within the biceps muscle of the arm. There is no ground to believe the mass originated from a periosteal flap as in Case XV, where ossifications occurred in a period of seven years, after comparatively slight injuries and disappeared spontaneously. In one instance only the inflammatory symptoms were very marked: after a time a bony sequestrum loosened itself and the process healed after treatment with an autovaccine. It would prove the changes were due to a microörganism similar to those of a chronic osteomyelitis. But even here an assumption of a congenital inclination seems unavoidable.

Case XVI gives a very rare condition of metaplastic bone development on a base of neoplasmatic process.

In Case XVII bone formation within a laparotomy scar, a lesion of periosteum, can be absolutely excluded.

In regard to the general tendency or dyscrasia it is very difficult to make a precise definition. Whether we are dealing with general appearance of an insufficient differentiation of cells, descending from mesoblast in the whole organism or possibly in one part of it, or the tendency is acquired and based only upon a disturbance within the calcium management, as a factor acting generally, possibly under the influence of inner secretory glands, or but locally reducing the muscle or nerve sensibility, or by way of trophic nerves, is difficult to say. This only one seems to be sure that the last cause is always the process of inflammation, the same whether due to a severe injury or a small hemorrhage or a luxation, whether raised by microörganisms or by an aseptic knife. From that standpoint any form of myositis ossificans could be considered as a traumatic one.

CONCLUSIONS

1. The opinion, advanced by Machol, that not to a dislocation of the elbow itself, but to the reposition, is due to development of parosteal callus after dislocations is not right, as proved by the Cases X, XI.

2. The statement, that an ossification never occurs near a chronic destruction of a living bone, is annulled by the Cases I, IV, V, XIV. In four of sixteen cases, ossification developed in the neighborhood of a chronic diseased joint without any trauma preceding.

3. Parosteal bone formation, exostosis and chronic deforming joint changes occur often in the same individual, suggesting there must be a connection between them.

4. Bone formation after backward dislocations of the elbow originate from periosteum as well as from joint capsule, probably with addition to a local disposition.

5. Assumption of a special tendency, congenital or acquired, for the development of a metaplasia is unavoidable at present as well as for excessive callus formation.

6. Myositis ossificans is a reparative process within the young connective tissue, originated by inflammation.

7. All forms of parosteal bone are identical as regards the trauma given inflammation, regardless to what sort of irritation the last may follow.

In conclusion I desire to express my hearty thanks to Prof. Dr. H. Schramm for his advice and opportunity given me to accomplish my article.

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GASTRIC RESECTION FOR PYLORIC AND DUODENAL ULCER

A PRELIMINARY REPORT

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Excision of the pylorus and the first part of the duodenum has not been accepted in all clinics as the method of choice in the treatment of patients with ulcer. However, the increasing frequency of excision for ulcer alone and the failure of other surgical measures in the cure of a relatively large number of patients, justifies a careful study of the method employed. Since the first successful partial gastrectomy in 1881 by Billroth, the third reported up to that time, various procedures for the restoration of these parts have been suggested and employed. Because of the ruling factor, carcinoma and its dissemination, the first successful excision, and in the main, those following have been planned and carried out with the chief intent, that of removal, and then restoration of function as near as possible. In the presence of carcinoma restoration of function in part, or in any fashion that would work, has seemed to be

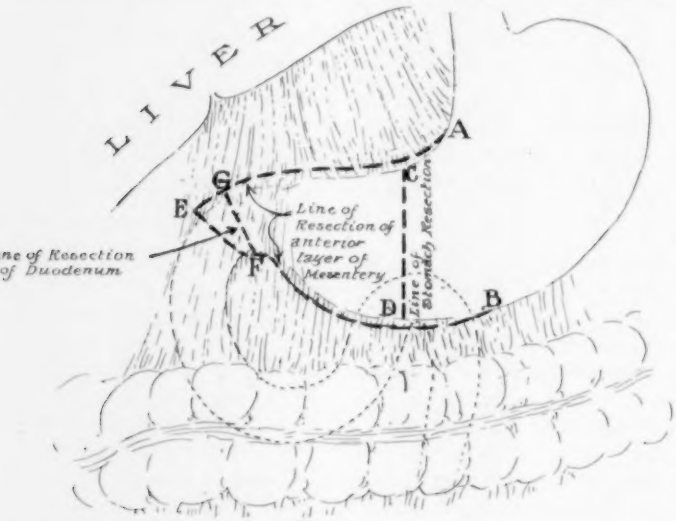

Fig. 1.

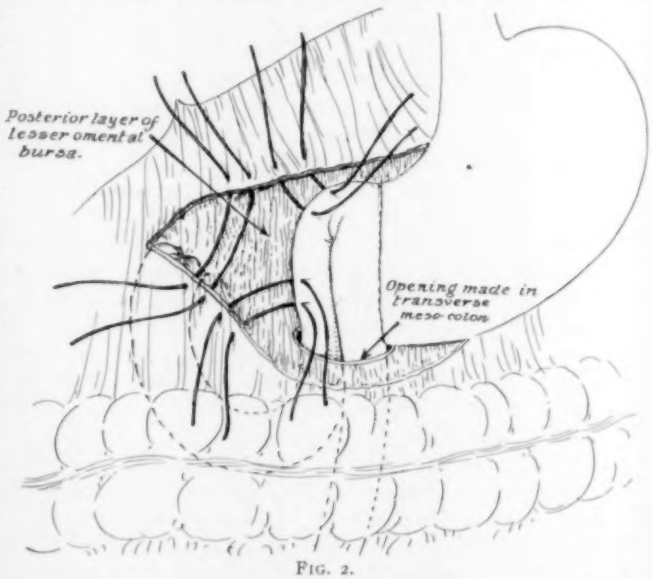

Fig. 2.

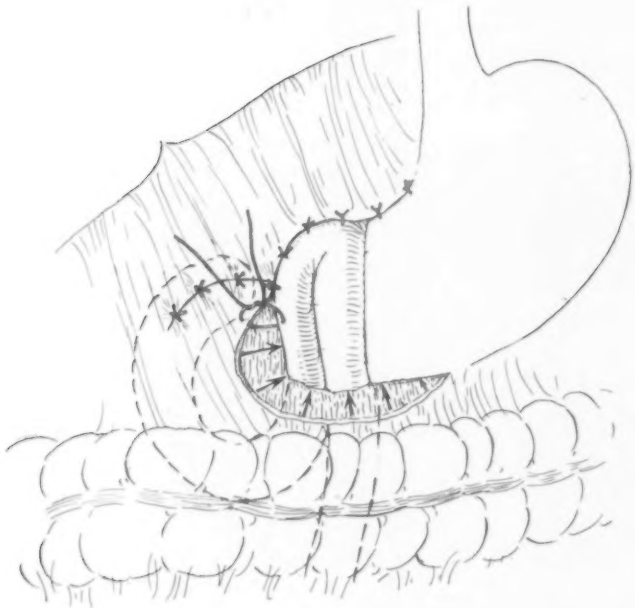

FIG. 3.

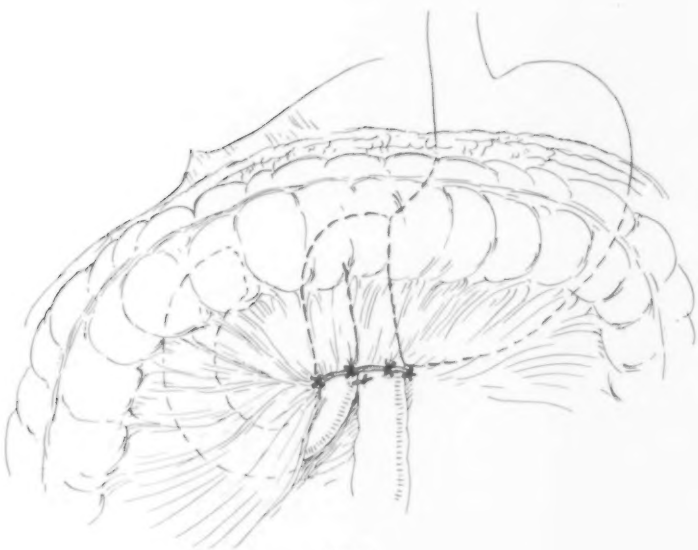

FIG. 4.

justified. Any loss of physiological function of the stomach from the successful removal of a carcinoma will continue to be justified.

In the case of ulcer, excision may be limited to the stomach and duodenum and less of that suffices. The mesentery and that part of the stomach above the line C-D (Fig. 1) being useful and not involved in the disease should be kept and made to serve in the preservation and restoration of function in these organs.

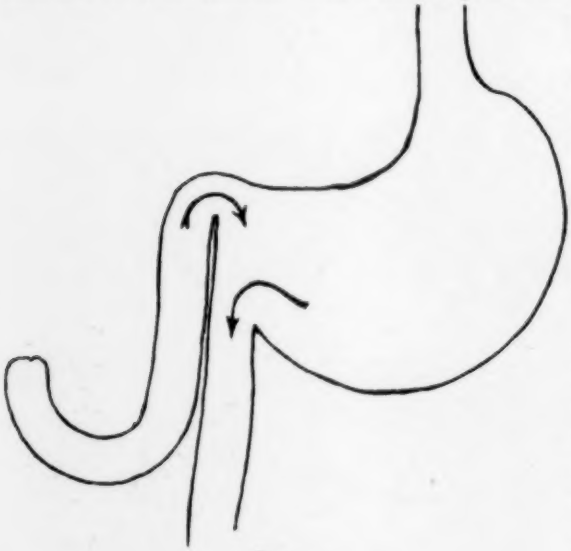

FIG. 5.

Maintaining the physiologic function of the stomach and restoring the mechanical action of the organs involved is a more important consideration in ulcer than in carcinoma. The surgical treatment of ulcer of stomach and duodenum has been grafted on the surgical treatment of carcinoma of the stomach rather than developed to meet the needs of the patient with ulcer. Because of this the operation herein outlined is offered and in that it meets the anatomical requirements of:

1. Excision of the ulcer-bearing area.

2. Maintenance of physiologic activity of the stomach, in so far as possible.

3. Restoration of anatomical function of stomach.

4. Insures a thorough admixture with alkalinization of the stomach content.

5. Leaves no opening in either the anterior or posterior walls of the lesser omental bursa.

FIG. 6.

The steps of the proposed method are as follows:

Figure 1.—Incision through the anterior wall of the lesser sac on the line AE-FB, keeping close to the curvature of the stomach and duodenum and carrying this incision back far enough on stomach and duodenum to insure sufficient free portion of both to enable the closure and anastomosis to be made with ease.

Figure 2.—Gastrojejunostomy by suturing the entire width of the stomach into the longitudinal opening in the distal half of the jejunal loop. Sutures placed in gastrohepatic and gastrocolonic omentum.

Figure 3.—Closure of the anterior wall of the lesser sac by attachment of gastrohepatic omentum to the lesser curvature of the stomach and convex surface of the jejunum and gastrocolonic omentum to the proximal and distal loop of the jejunum and greater curvature of stomach, thereby fixing the

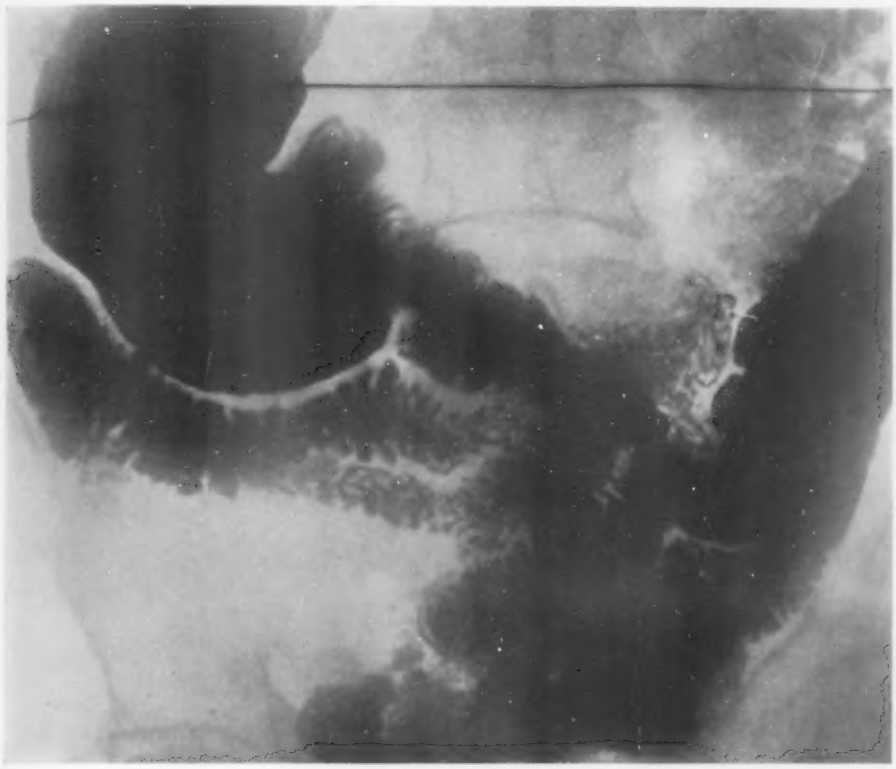

FIG. 7.

jejunum in this position and maintaining the normal anatomical position of the stomach.

Figure 4.—Suture of the margin of the opening made in the colonic mesentery about the proximal and distal loop of the passing jejunum, thereby fixing the jejunum and closing the opening in the posterior wall of the lesser sac.

Figure 5 is a drawing to represent the position of the stomach and the direction of the duodenal and stomach content when the jejunum is brought through the colonic mesentery and attached to the end of the pylorus.

Figure 6 is a drawing to represent the position of the stomach and the current of the duodenal content when the stomach is drawn through the colonic mesentery and sutured into the jejunum.

Figure 7.—A skiagraph of the stomach in a patient two years following operation by this method. The stomach fills to normal capacity and empties in three and one-half hours. Peristaltic action of stomach maintained. Position of jejunum is that aimed at in the drawings. Peristaltic action of the distal loop of the jejunum has not been interfered with by the longitudinal opening made for the anastomosis. There has been no dilatation of the distal loop, and there is no apparent back tracking of stomach content into the proximal loop of the jejunum.

FIG. 8.

Figure 8 represents diagrammatically the anastomosis as it remains two years after operation. The stomach A and the distal loop of jejunum are traced from the X-ray Fig. 7, with the proximal jejunum B, added to correspond in size and position with C as it shows in Figure 5.

FAILURE OF GASTRO-ENTEROSTOMY TO EFFECT A DECISIVE REDUCTION IN GASTRIC ACIDITY

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The curative effect of gastro-enterostomy on pyloric and duodenal ulcers is usually ascribed to three substantial changes in the mechanics and chemistry of the stomach brought about by this operation, (1) the side-tracking of the food, (2) a marked reduction of the hyperacid stomach juice by the regurgitation of bile through the gastro-enterostomy stoma, and (3) the relief of pylorospasm with consequent healing of the ulcer. It is generally assumed that these three factors play a very important rôle in the healing of pyloric and duodenal ulcers. In fact, in most of the surgical text-books, published during the last thirty years, these three points are mentioned as the causes for the cure of ulcers following gastro-enterostomy. Students are given the impression that these are not theories, but facts, and that the value of gastro-enterostomy as a side-tracking and acid-reducing operation has been established beyond doubt.

The medical and surgical profession have also accepted the correctness of these statements. Careful investigations, however, by different authors, have thrown serious doubt on the supposition that gastro-enterostomy side-tracks the food and thus favors healing of the ulcer, by putting the pylorus and duodenum at rest.

Kelling [1] established two intestinal fistulæ on gastro-enterostomized dogs, one in the jejunum distal to the gastro-enterostomy and one in the duodenum. Most of the methylene-blue solution given to the dogs came out through the duodenal fistula; less than 10 per cent. passed through the gastro-enterostomy.

Cannon,[2] who studied the function of gastro-enterostomy with the aid of röntgenography, came to the following conclusions: "The idea that gastro-enterostomy represents a drainage operation is wrong. There can be no doubt that in animal experiments the natural exit of the food is through the pylorus and not through the artificial opening, when both ways are offered for the passage of the food."

Lewisohn [3] demonstrated that after feeding thionin-blue to gastro-enterostomized dogs the stomach, the duodenum and the jejunum below the stoma show the same dark blue color. In other words, he demonstrated that in spite of the gastro-enterostomy a large part of the fluid passed through pylorus and duodenum. When pyloric exclusion according to Berg's method was added to the gastro-enterostomy, only a slight trace of thionin-blue was

* Read before the New York Surgical Society, October 14, 1925.

found in the duodenum, whereas the jejunum showed the same dark green-bluish color, as in the first series of experiments.

Many other authors have made similar observations which tend to show that in the presence of an open pylorus most of the food passes through the duodenum, in spite of the presence of a gastro-enterostomy.

If we begin to peruse the literature on the second point, *i.e.*, the reduction of hyperacidity following gastro-enterostomy, we find practically uniform agreement among the authors that regurgitation of bile through the newly established stoma reduces the hyperacid gastric juice to a very marked degree. Innumerable papers have been written on this subject. They are practically in accord that gastro-enterostomy causes either a complete anacidity or a marked reduction of the acid figures.

However, a few dissenting voices have been heard during the last few years. Conybeare [4] states that following a gastro-enterostomy most of the duodenal ulcer cases have a high acid figure.

Wydler,[5] who examined gastro-enterostomized patients one to seven years after the operation, found a marked reduction of the acid values immediately after the operation. However, these reductions were not in evidence, when he examined the patients a number of years after the operation.

Wilensky and Crohn [6] observed in 32 cases that the acidity is diminished following gastro-enterostomy, "though not to a considerable degree."

A recent study of the frequency of gastro-jejunal ulcers [7] afforded an opportunity of investigating, whether gastro-enterostomy reduces gastric hyperacidity. Eighty-eight patients operated upon between 1915 and 1920 were reëxamined with the aid of an Ewald test-meal. Seventy-eight of these were men and 10 were women. The vast majority of these patients had an Ewald test-meal given to them before the operation and 11 had been reëxamined before they left the hospital. Thus we were able by comparing these figures with those obtained after an interval of between three and eight years to get some definite data on acid figures following different methods of gastric operations, among them mainly partial gastrectomy and gastro-enterostomy with or without pyloric exclusion.

It was impossible in covering this fairly large number to use the Rehfuss fractional test. This test is much more time-consuming, not only for the doctor, but for the patient. In fact, a goodly number of patients objected for various reasons (inconvenience, lack of time) to any form of gastric analysis. Some claimed that they were feeling well and did not want to undergo the annoyance of another test-meal. Thus about 20 per cent. of the available cases could not be included in this series.

Another reason for confining ourselves to the Ewald test-meal, in preference to the fractional test, was based on the fact that the Ewald test-meal had been used in the vast majority of patients before the operation. The best way, to acquire correct data for comparison, seemed to be to apply the same method which had been used before the operation.

Furthermore, in 14 patients, in whom both an Ewald and a Rehfuss test-

meal had been given before operation, we could observe that no marked difference between the figures obtained by these two methods was evident. The same observation was made in 6 out of these 14 patients, who had both Ewald and Rehfuss test-meals before and after operation. In other words, though slight differences in the figures are not unusual, no marked discrepancies in the acid curves were observed, no matter what method was used for the test-meal.

Private patients and a small number of patients operated upon on one of the other three surgical services were not included in this review. Their examination would have been connected with too many difficulties, as they are not observed in the follow-up system of this service.

It must be stated that the 88 patients comprise less than half of the number of patients operated upon on this service for gastric or duodenal ulcers between 1915–20. The total number of gastric operations for ulcer in the stomach or duodenum during this period amounted to 213 cases. As 22

TABLE I

Partial and Subtotal Gastrectomies for Gastric Ulcers

Name	Year of operation	Acid figures before operation	Acid figures in 1923–24
1. B. B.	1918	1910: Gastro-enterostomy 1918: 40–60. Partial gastrectomy for recurrent ulcer	0-20*
2. H. D.	1918	80–27	0–16
3. L. N.	1918	40–88	17–28
4. S. K.	1919	55–70	0–16
5. M. B.	1919	66–94	0–12
6. E. K.	1919	22–50	0–12
7. D. W.	1920	57–70	12–28
8. M. S.	1920	20–60	0–16
9. M. R.	1920	(Bleeding gastric ulcer)	0–25

*0–20 indicates free HCl:0, total acids:20

patients died following the operations, we could have reported on end results of gastric acidity in 191 patients, if we had been able to trace them and if all patients had been willing to submit to another test-meal.

Table I shows the acid figures from three to five years after partial or subtotal gastrectomy for gastric ulcers. None of these patients had a preoperative anacidity. Three of them had a marked hyperacidity. Different authors have claimed that gastric ulcers are frequently connected with anacidity, whereas duodenal ulcers show marked hyperacidity. This observation is contrary to our experience, not only in the small number of 11 gastric ulcers presented in Tables I and II, but in a large series of gastric ulcers, operated on this service since 1920, cases which are not included in this series. In

fact, we have found that the vast majority of ulcers in the stomach show hyperacidity and that anacidity is a rare occurrence in the presence of a gastric ulcer.

Table I shows that a marked reduction of the acid figures was observed in every case of partial or subtotal gastrectomy for gastric ulcer. In 7 out of 9 cases (77 per cent.) a complete † permanent anacidity was obtained. In the other two cases the reduction was considerable (in one case from 57 to 12, in the other from 40 to 17). Absence of free HCl following operations on the stomach is to be considered a desirable sequel, for permanent anacidity practically guarantees a lasting cure to the patients. The anacidity produces no symptoms. We have observed a large number of patients over a period of many years and know that they are completely free from gastric symptoms after removal of one-half or even two-thirds of the stomach. Absence of free HCl practically safeguards against recurrence of ulcer, either in the stomach or duodenum, or at the site of the gastro-enterostomy stoma. Lorenz and Schur [8] pointed out some years ago, that, if antrum and pylorus are removed and the line of resection is kept 8–10 cm. from the pylorus, a marked hyperacidity is immediately changed into a complete anacidity. Partial or subtotal gastrectomy is the only gastric operation which is followed by an immediate and permanent anacidity in nearly 80 per cent. of the cases and at the same time gives good functional results.

We have never observed a case of pernicious anæmia following partial or

TABLE II

Sleeve Resection for Gastric Ulcer

Name	Year of operation	Acid figures before operation	Acid figures 1923–24
1. T. R.	1916	61–79	0–16
2. N. B.	1917	18–34	0–21
3. H. S.	1917		0–57

subtotal gastrectomy and our observations extend back over a period of twelve years.

Table II shows a small number of cases (3) in which sleeve resection for gastric ulcer was performed about nine years ago. The number is very small, as this operation was abandoned after a few trials in favor of partial gastrectomy. A permanent anacidity was obtained in these three cases. Thus the change of a hyperacid stomach contents into an anacid one was effected by this method. These ulcers were all situated midway between cardia and pylorus at the so-called reëntrant angle. It is well known that this location is the place of predilection for the vast majority of ulcers of the lesser curvature. It is interesting to note that a permanent anacidity was obtained in these cases, in spite of the fact that pylorus and antrum were not removed.

† By complete anacidity we mean complete absence of free HCl.

Lorenz and Schur [8] have pointed out that in order to establish a permanent anacidity, pylorus and antrum up to about 10 cm. from the pylorus must be resected. However, the permanent anacidity obtained after a sleeve resection shows, that the same result can at times be obtained by removing a comparatively small sleeve at the reëntrant angle without removal of antrum and pylorus. *The reëntrant angle evidently plays an important rôle in the question of gastric acidity.* Berg thinks that this point contains some very important nerve centres which influence gastric secretion. Further experimental work along these lines may clear up this very important question which, up to date, has not been sufficiently studied.

Goecke [9] also observed that all sleeve resections were followed by anacidity, whereas Faulhaber and v. Redwitz [10] found anacidity in only 50 per cent. of their cases.

Our reason for discontinuing sleeve resection on this service, was that the functional motor results were very unsatisfactory. Two out

TABLE III

Pylorectomy for Pyloric Ulcer

Name	Year of operation	Acid figures before operation	Acid figures 1923–24
1. J. P.....	1917	64–102	42–70
2. S. B.....	1920	79–90	40–45 1924: Subtotal gastrectomy for gastro-jejunal ulcer. 1925: 0–28

of three cases have hour-glass formation at present, with fairly marked symptoms of retention. They could be cured by a subtotal gastrectomy. If these patients had been submitted to a partial or subtotal gastrectomy at the time of the primary operation, the functional results would have been far superior to those obtained by sleeve resection. The same bad functional results were obtained in a series of private cases, operated by Doctor Berg, which are not included in this report. For this reason sleeve resection was abandoned on this service many years ago, in spite of the fact that others (Judd,[11] Downes,[12]) have had satisfactory results following this operation.

Our operative procedure should be governed by three points of view: It should remove the ulcer and the ulcer-bearing area; (2) it should guarantee a perfect functional result (large stoma, normal emptying time, etc.), and (3) it ought to establish a permanent anacidity in order to prevent the recurrence of an ulcer. Though sleeve resection is followed by anacidity, apparently bad functional motor results make this method decidedly inferior to partial or subtotal gastrectomy.

Table III demonstrates acid figures in two cases of pylorectomy. Both cases showed a considerable amount of acidity, when reëxamined six and three years after the operation. One of these patients (S. B.) developed a gastro-

jejunal ulcer. He was re-operated last year. A subtotal gastrectomy was performed. It is interesting to note that he has now a complete absence of free HCl. In other words, the more radical procedure effected, what simple pylorectomy failed to do, *i.e.*, the establishment of an anacidity. Gastro-jejunal ulcer following simple pylorectomy is not a rare occurrence. Three cases were observed in this hospital and reported in a previous paper.[7] Partial

TABLE IV

Excision of Ulcer with or without Gastro-enterostomy

Name	Year of operation	Acid figures before operation	Acid figures in 1923–24
1. D. F.....	1915 Excision gastric ulcer	60–90	10–52
2. J. G.....	1917 Excision gastric ulcer. Secondary gastro-enterostomy in 1922	0–14	23–32
3. S. S.....	Excision gastric ulcer plus gastro-enterostomy, 1917	35–60	49–72
4. D. B.....	Excision gastric ulcer plus gastro-enterostomy, 1917	15–65	10–25
5. M. J.....	Excision duodenal ulcer, gastro-enterostomy, plus pyloric exclusion, 1918		1920: 68–88 1921: partial gastrectomy for recurrent duodenal ulcer. 1923: 0–10
6. S. M.....	Excision duodenal ulcer, gastro-enterostomy plus pyloric exclusion	67–90	35–55
7. A. S.....	Pyloric ulcer, excision plus gastro-enterostomy, 1919		55–72
8. A. U.....	Excision gastric ulcer plus gastro-enterostomy, 1919		5–25
9. B. D.....	Excision pyloric ulcer plus gastro-enterostomy, 1919		55–90
10. H. G.....	Duodenal ulcer, excision plus gastro-enterostomy, 1919	67–110	7–80
11. D. G.....	Duodenal ulcer, excision plus gastro-enterostomy, 1920	90–100	19–55 (before radical operation). 1922 subtotal gastrectomy for gastro-jejunal ulcer 1923: 0–20

gastrectomy cannot be considered a more serious operation than pylorectomy. However, this more radical procedure safeguards the patients against the development of a subsequent gastro-jejunal ulcer. For this reason pylorectomy, even in small pyloric ulcers, has been abandoned on this service for a number of years and has been replaced by partial or subtotal gastrectomy. Since this method has been used as the method of choice in practically every case, gastro-jejunal ulcers, which used to be the " bête noire " in our stomach work, have not been observed by us.

We have grouped in Table IV, 11 cases in which a local excision of the ulcer situated either in the stomach or in the duodenum was performed, with or without gastro-enterostomy. Operations performed in the attempt to remove the local lesion were the following:

Location of ulcer	Method of operation	No. of cases
Gastric ulcer of the lesser curvature	Local excision	2
Gastric ulcer of the lesser curvature	Local excision and gastro-enterostomy	2
Pyloric ulcer	Local excision and gastro-enterostomy	2
Duodenal ulcer	Local excision and gastro-enterostomy	3
Duodenal ulcer	Local excision, gastro-enterostomy and pyloric exclusion	2

In two of our earlier cases of gastric ulcer a simple excision was performed. The functional results following this simple operative procedure were very unsatisfactory. In fact, one of these cases required a secondary gastro-enterostomy five years after the primary operation. For this reason local excision without gastro-enterostomy has not been used in gastric ulcers for many years. However, even local excision combined with gastro-enterostomy failed to give good results. As soon as partial or subtotal gastrectomy was used consistently in this group of cases, the functional results were perfect. It seems of importance to point out, that the radical procedure was introduced on this service only after many attempts to cure this group of patients by more conservative methods had failed.

A marked reduction in the figures for free HCl was obtained in Case 1 (gastric ulcer). Case 4 showed about the same acid figures when reëxamined six years after the operation, as those obtained before the excision and gastro-enterostomy. Case 8 showed a low figure upon reëxamination after four years. However, it is impossible to state whether this low figure represented a reduction of the pre-operative acidity, as no test-meal was taken before the operation. It is well known that some gastric ulcers have a low acidity, and it is possible that this patient had low acid figures, before he was operated upon.

Case 2 showed a marked rise in the figures. Before the first operation (local excision) he had absence of free HCl. Immediately after the operation the figures were 46–70. A secondary gastro-enterostomy was performed in 1922. When reëxamined in 1923 his figures were 23–32.

Two patients (Nos. 7 and 9) with pyloric ulcer, in whom the ulcer had been excised and a gastro-enterostomy had been performed, showed high acid figures five and four years after the operation. No pre-operative test-meals were available for comparison.

Among the five cases of duodenal ulcers treated with local excision and

gastro-enterostomy (three of these had a pyloric exclusion performed in addition to the gastro-enterostomy) Case 3 showed a rise in the acidity when reëxamined after six years. Three cases (Nos. 6, 10 and 11) showed a marked reduction in their acid figures, but not an anacidity. The last of these cases (No. 11) developed a gastro-jejunal ulcer. He was subjected to a subtotal gastrectomy in 1923 and has now—in conformity with practically all partial or subtotal gastrectomies—absence of free HCl.

Case 5 had no pre-operative test-meal. The primary gastro-enterostomy with excision of a duodenal ulcer was performed in 1918. His acid figures in 1920 were 68–88. He was re-operated in 1921 for recurrent duodenal ulcer. A partial gastrectomy was performed. When reëxamined in 1923 his acid figures were 0–20.

If we correlate these data we observe the following interesting facts: Conservative operations (excision of the ulcer with or without gastro-enterostomy) failed to effect a complete anacidity among 11 cases of gastric or duodenal ulcers. However, a complete absence of free HCl was established in two of these cases following a partial or subtotal gastrectomy, after they had developed recurrent ulcers. These two patients submitted to the radical operation after they had been chronic invalids for years. They are in perfect health since the last operation.

Though this paper does not deal with clinical end results, it may be of interest to point out that 9 patients still have gastric symptoms. Local excision of ulcer with or without gastro-enterostomy is generally considered a very good surgical procedure. Only two out of the 11 patients are perfectly well (18 per cent.). From this experience it is evident that, although our series is small, this form of operation is by no means satisfactory as to end results.

Table V shows the acid figures in 13 cases after simple gastro-enterostomy for pyloric or duodenal ulcer. None of these cases had an absence of free HCl upon reëxamination, except Case 9. This patient, however, had been subjected to a subtotal gastrectomy one year after the gastro-enterostomy on account of marked retention with vomiting. In all the other patients, with the exception of Case 12, free HCl was above 26. Only one case (No. 5) had very high acid figures before operation (78–109). The pre-operative figures for free HCl in the other cases ranged between 36 and 62. It is safe to predict, that a permanent anacidity would have been established in these cases, if partial gastrectomy had been substituted for simple gastro-enterostomy. Three cases (Nos. 7, 10 and 11) had a higher acidity upon reëxamination than before the operation.

A perusal of 50 cases of gastro-enterostomy with pyloric exclusion (Berg's[12] method) for pyloric and duodenal ulcers shows the following results as to post-operative gastric acidity:

In 8 patients (11, 14, 15, 20, 21, 28, 38, 40) figures for free HCl were higher than they had been before the gastro-enterostomy. In 4 patients (12, 35, 42, 48) pre- and post-operative acidity were the same. In 28 patients

(1, 2, 3, 4, 5, 7, 8, 9, 10, 13, 17, 18, 19, 22, 23, 25, 30, 33, 34, 37, 41, 43, 44, 45, 46, 47, 49, 50) the acid figures were reduced. However, the reduction of acidity was a moderate one in the vast majority of the cases. In spite of the fact that 17 among these 28 cases had a pre-operative figure for free HCl of 40 and more, only 7 cases (25 per cent.) showed a very decided drop. As stated above, the immediate drop from high acid figures to 0 is the usual occurrence following partial or subtotal gastrectomy. On the other hand, these figures show that absence of free HCl is extremely

TABLE V

Gastro-enterostomies

Name	Year of operation	Acid figures before operation	Acid figures 1923–24
1. A. B.	1917		45–88
2. I. N.	1917	45–75	41–62
3. M. P.	1917	40–60	35–44
4. H. L.	1917	53–75	29–52
5. H. J.	1917	78–109	39–56
6. M. F.	1918	55–91	28–37
7. A. D.	1918	20–44	48–62
8. N. R.	1919		26–51
9. M. R.	1919	55–88	1920: subtotal gastrectomy 1923: 0–27
10. B. G.	1919	62–70	68–96
11. J. G.	1919	36–77	41–58
12. M. K.	1919	45–85	16–37

rare following gastro-enterostomy. Anacidity was established only twice in 47 cases.

Seven cases (24, 26, 27, 29, 31, 32, 36) had no test-meal before the operation. In 2 cases (16, 39) acid figures were not recorded after the operation. These 9 cases were, therefore, not available for comparison.

A secondary partial gastrectomy was performed for recurrent duodenal ulcer with profuse hemorrhages in Case 6. His acid figures before the primary operation were 40–60. No test-meal could be taken before the secondary operation on account of profuse gastric hemorrhages. Partial gastrectomy performed nine years after the primary operation, established an anacidity (0–20).

Thus among 69 cases of gastro-enterostomy (10 of these with local excision of the ulcer) complete anacidity was obtained in only two cases (less

TABLE VI

Gastro-enterostomies with Pyloric Exclusion

(Berg's Method)

Name	Year of operation	Acid figures before operation	Acid figures in 1923–24
1. F. H.	1915	52–95	20–40
2. M. S.	1915	51–64	23–33
3. M. F.	1915	32–62	16–22
4. B. H.	1915	20–40	0–21
5. M. H.	1915	60–90	26–56
6. S. S.	1915	40–60	1924: partial gastrectomy for bleeding duodenal ulcer. 0–20
7. S. P.	1915	61–77	35–55 1924: partial gastrectomy for gastro-jejunal ulcer 1925: 0–9
8. M. K.	1916	65–90	39–47
9. L. B.	1916	50–75	25–46
10. J. R.	1916	40–80	26–38
11. A. R.	1916	42–60	48–70
12. W. R.	1916	38–74	40–80
13. S. F.	1916	50–93	12–37
14. J. K.	1917	61–81	78–90
15. H. B.	1917	26–52	59–75, subtotal gastrectomy for gastro-jejunal ulcer; exitus.
16. M. C.	1917	60–100	1924:partial gastrectomy for gastro-jejunal ulcer; cannot be traced.
17. J. K.	1917	70–94	30–45
18. M. S.	1917	66–86	30–54
19. L. K.	1917	75–98	1922: excision gastro-jejunal ulcer; 1923: before radical op. 34–49; 1923: subtotal gastrectomy for recurrent gastro-jejunal ulcer; 1925: 0–12
20. B. J.	1917	20–38	25–52
21. M. S.	1917	29–55	35–50
22. B. G.	1917	56–83	12–29
23. H. P.	1917	66–108	32–41
24. A. B.	1917		40–57
25. S. S.	1917	50–75	38–66

TABLE VI—(*Continued*)

Gastro-enterostomies with Pyloric Exclusion
(*Berg's Method*)

Name	Year of operation	Acid figures before operation	Acid figures in 1923–24
26. M. S.	1917		25–45
27. S. W.	1917		50–85
28. F. K.	1918	55–70	65–82. Has gastro-jejunal ulcer.
29. S. G.	1918		48–80
30. B. M.	1918	90–120	38–76
31. J. M.	1918		61–79
32. H. F.	1918		48–59
33. J. S.	1918	60–80	35–55
34. B. S.	1918	70–90	35–60
35. C. K.	1918	40–70	40–70
36. L. B.	1918		37–54
37. L. Z.	1918	35–56	20–38
38. P. T.	1918	40–70	72–85
39. D. H.	1918	22–59	Re-operated, partial gastrectomy. Exitus.
40. J. C.	1918	36–57	51–72
41. H. A.	1918	55–80	20–37
42. B. G.	1918	50–70	50–80
43. A. K.	1918	70–90	21–39
44. R. L.	1919	40–64	33–60
45. R. G.	1919	40–52	5–16
46. J. A.	1919	55–87	41–64
47. M. A.	1919	55–87	0–18
48. A. F.	1919	33–56	30–50
49. M. K.	1920	85–100	40–61 Patient has gastro-jejunal ulcer.
50. F. F.	1920	95–115	60–72

than 3 per cent.), whereas Table I showed absence of free HCl following partial or subtotal gastrectomy in 77 per cent. of the cases.

In Table VII are grouped those cases which required a secondary partial or subtotal gastrectomy for gastro-jejunal or recurrent duodenal ulcer. In one case (VI, 6) no test-meal could be taken before the secondary operation on account of very profuse hemorrhages. In one case (V, 9) no test-meal

TABLE VII

Secondary Partial or Subtotal Gastrectomy for Gastro-jejunal or Recurrent Duodenal Ulcer

No.	Acidity before gastro-enterostomy	Acid figures before radical operation	Partial or subtotal gastrectomy	Acid figures after radical operation
I, 1, B. B.	1910: gastro-enterostomy for gastric ulcer	1918: 40–60	1918: Partial gastrectomy for recurrent gastric ulcer	1923: 0–20
III, 2, S. B.	79–90—1920 pylorectomy for pyloric ulcer	1923: 40–45	1924: subtotal gastrectomy for gastro-jejunal ulcer	1925: 0–28
IV, 5, M. Z.	1918: excision duodenal ulcer, gastro-enterostomy plus pyloric exclusion 1920: removal of button	1920: 68–88	1921: partial gastrectomy for recurrent duodenal ulcer	1923: 0–10
IV, 11, D. G.	90–100—1920: excision duodenal ulcer, gastro-enterostomy	1922: 19–55	1922: subtotal gastrectomy for gastro-jejunal ulcer	1923: 0–20
V, 9, M. R.	55–88—1919, gastro-enterostomy for cicatrized pyloric ulcer		1920: subtotal gastrectomy for retention	1923: 0–27
VI, 6, S. S.	40–60—1915: gastro-enterostomy plus pyloric exclusion for duodenal ulcer		1924: partial gastrectomy for recurrent bleeding duodenal ulcer	1924: 0–20
VI, 7, S. P.	61–77—1915: gastro-enterostomy plus pyloric exclusion for pyloric ulcer. Acidity before 2nd operation: 46–55, 1919: excision gastro-jejunal ulcer	1924: 22–40	1924: partial gastrectomy for gastro-jejunal ulcer	1925: 0–9
VI, 19, L. K.	1916: gastro-enterostomy for duodenal ulcer, 1922: excision gastro-jejunal ulcer	1923: 34–49	1923: subtotal gastrectomy for recurrent gastro-jejunal ulcer	1925: 0–12

was taken before the secondary operation. In the other 6 cases free HCl varying between 19 and 68 was recorded. In all these 8 cases complete anacidity followed the partial or subtotal gastrectomy. In other words, what gastro-enterostomy had failed to do, was established following the more radical procedure in 100 per cent. of the cases recorded in Table VII.

The question of anacidity following a gastric operation is by no means of academic interest only. It is a distinctly practical question of great importance. Partial or subtotal gastrectomy for gastric ulcer, no matter whether the ulcer was large or small, has been performed for many years on this

service, as well as in a number of other clinics. The results were uniformly good, after the proper technic had been established.

Haberer [14] applied the same principle (*i.e.*, partial or subtotal gastrectomy) to the surgical treatment of duodenal ulcers. He had encountered many failures (recurrent ulcers, gastro-jejunal ulcers, etc.) following gastro-enterostomy with or without exclusion, whereas his results in gastric ulcers following partial gastrectomy had been uniformly good. He then applied the more radical principle to the surgical treatment of duodenal ulcers. His results since then, covering a period of about five years, have been very excellent. The distressing picture of the patient, who was often in worse condition after the gastro-enterostomy than before he entered the hospital, was banished from his service.

Haberer did his excellent work on a purely empirical basis. Lorenz and Schur [8] showed that the reason for the absence of recurrent ulcers following partial or subtotal gastrectomy seems to be the establishment of a permanent anacidity.

It is a well-known fact that gastro-jejunal ulcers practically never occur in an anacid stomach. In a statistical study of the frequency of gastro-jejunal ulcers,[7] 18 per cent. of the cases required re-operation for gastro-jejunal ulcer. Another 16 per cent. had the clinical signs and X-ray findings of a new ulceration at the site of the stoma. When 34 per cent. of a given series are suffering from this very serious complication, the question of how to avoid their occurrence becomes one of prime importance.

In spite of the fact that so many gastro-jejunal ulcers occurred on this service, this complication was never observed in an anacid stomach. We know very little about causation of ulcers. But we seem to have one safe way of preventing a recurrent ulcer or a subsequent gastro-jejunal ulcer, *i.e.*, the establishment of a permanent anacidity by partial or subtotal gastrectomy.

We have never claimed that gastro-enterostomy is a failure in every case. In fact, 50 per cent. of the cases in the series quoted above [7] seem to be permanently cured. However, an operation should offer more to a prospective patient than one chance in two of being cured. In looking over the gastro-enterostomies recorded above, we find that less than 3 per cent. were anacid, whereas 77 per cent. among the partial or subtotal gastrectomies performed during the same period had an anacidity. Therefore, we agree with Lorenz and Schur [8] that the establishment of anacidity is a very important factor in the selection of our operative procedure. Partial gastrectomy and sleeve resection seem to be the only two methods at our disposal which establish a permanent anacidity. Sleeve resection, however, should not be used on account of the bad functional motor results. Thus partial or subtotal gastrectomy seems the method of choice, if we want to safeguard our patients against recurrences.

Sherren,[15] in a recent article, states that he is a "whole-hearted believer in the chemical action of gastro-enterostomy, as opposed to the purely mechanical. If the post-operative test-meal showed little or no reduction of

acidity, although the stomach may be emptying rapidly through the new opening, the patient may have further digestive trouble." Among 285 cases of chronic duodenal ulcers, in which gastro-enterostomy with or without excision of the ulcer was performed, 131 were anacid.

Sherren's figures of 45 per cent. anacidity contrast strongly with our figures which show 3 per cent. anacidity for the same group of cases. We hope that other clinics will investigate their material along the same lines in order to settle this point definitely.

How can we explain that a number of cases are permanently cured after gastro-enterostomy? If side-tracking of the food does not occur and if, as we have shown above, no marked change in the chemistry of the gastric juice takes place following gastro-enterostomy, what is the reason that 50 per cent. of our cases operated between 1915 and 1920 are perfectly well? It is impossible to make any definite statements in explanation of this observation. However, it is very probable that in a certain percentage of the cases the pylorospasm is relieved following the gastro-enterostomy and that with subsiding inflammation the ulcer heals secondarily.

It is our firm belief that the enthusiasm for gastro-enterostomy will wane during the next few years and that in ten years from now gastro-enterostomy will be used for the treatment of pyloric and duodenal ulcers as a makeshift operation, not as the method of choice. The clinical results following the more radical procedures are so infinitely superior in every respect, that the surgical profession will gradually adopt this method as the only procedure which seems to guarantee a permanent cure to a patient suffering from gastric or duodenal ulcer.

CONCLUSIONS

(1) Complete anacidity (absence of free HCl) was observed in 77 per cent. of the cases of gastric ulcer treated by partial or subtotal gastrectomy between 1915 and 1920.

(2) During the same period complete anacidity was observed in less than 3 per cent. of the cases treated by gastro-enterostomy with or without excision of the ulcer.

(3) Pylorectomy does not effect an anacidity and is followed by gastro-jejunal ulcers in a considerable number of cases.

(4) Complete anacidity was established in 8 cases requiring partial or subtotal gastrectomy for gastro-jejunal or recurrent duodenal ulcer. These patients had suffered for years following the primary gastro-enterostomy. They are perfectly well since the radical operation.

(5) In order to prevent the occurrence of gastro-jejunal ulcers the primary operation ought to establish a permanent anacidity.

(6) Partial or subtotal gastrectomy is the only method of operation which establishes permanent anacidity in a large percentage of the cases.

(7) Partial or subtotal gastrectomy should be the method of choice in the surgical treatment of gastric and duodenal ulcers.

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INFANTILE PYLORIC STENOSIS

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The voluminous literature regarding the so-called congenital hypertrophic pyloric stenosis illuminates the subject from many angles. Various phases of the problem, however, remain obscure. Therefore, an inventory of the accumulated facts and theories concerning infantile pyloric stenosis seems justifiable.

Osler [1] rescued from oblivion the original graphic description by Beardsley [2] in 1788. Beardsley stated that a male child "in the first week of its infancy was attacked with an ejection of the milk and of every other substance it received into its stomach almost instantaneously and very little changed." The boy led a miserable existence and died at the age of five years. Necropsy revealed that "the pylorus was invested with a hard compact substance or schirrosity which so completely obstructed the passage into the duodenum as to admit with the greatest difficulty the finest fluid."

Regarding frequency, Hill [3] discovered the condition in five out of 1000 infants. Pehu and Pinel [4] compiled thirty-eight cases of infantile pyloric stenosis in France and seven in Italy. These figures from the Latin lands are in marked contrast to the many cases reported from the Anglo-Saxon and German countries.

The etiology of the hypertrophy remains problematical. Thomson [5] contends that the enlargement is a work hypertrophy resulting from spasm. Many observers, however, agree with Hirschsprung [6] that the hypertrophy is a true congenital malformation. In confirmation of the latter contention Dent [7] found the tumor in a seven months' fœtus. Walls [8] states that the hypertrophy has been seen in children that were still-born and Green and Sidbury [9] observed a definite pyloric tumor at operation in a baby three days old.

The pathology is definite. Wollstein,[10] for example, reports twenty-three post-operative necropsy findings. In each instance the circular muscle fibres were hypertrophied without connective-tissue hyperplasia. The submucosa was often œdematous. There was no mucosal inflammation. The normal thickness of the pyloric circular muscle under three months of age is not greater than 2.5 mm. The hypertrophied muscle at this age showed a circular layer of from 3 to 7 mm. in thickness. The average was 4.4 mm.

The syndrome restated merely for purposes of discussion comprises (1) projectile vomiting, (2) tumor, (3) peristaltic waves, (4) gastric retention, and (5) rapid loss of weight.

Regarding recognition of the tumor, Bolling [11] states that the mass was palpated in all but one of 454 cases. Still [12] failed to feel the tumor only twice in 248 cases and Poynton and Higgins [13] palpated the hypertrophy in

all of their 55 cases. On the other hand, Lewisohn [14] and others find that often the tumor is not palpable. And Strauss [15] contends that the feeling of the mass is a matter of personal equation.

The tumor may usually be felt a little to the right and above the umbilicus. We are reminded, however, by Gray and Pirie [16] that occasionally the mass may be lower. And Holt [17] states that there is apt to be considerable variation in its position. In a case of mine, for example, three observers felt the tumor, two of us together and one independently, slightly below the level of the umbilicus.

Downes [18] agrees with Gray and Pirie that the presence of the so-called tumor is pathognomonic of the disease. Still believes that the only absolute proof short of opening the abdomen is feeling the tumor and Poynton and Higgins hold that operation is rarely indicated without palpating the mass. Haggard [19] merely states that visible peristalsis is the best evidence except the tumor when felt. And other observers contend that the existence of the characteristic syndrome without feeling a tumor justifies the diagnosis.

Thomson, for example, stresses the significance of well-marked, forcible peristalsis and Holt emphasizes the diagnostic importance of abnormal gastric retention. Palmer [20] depends upon the diagnostic triology explosive vomiting, iso-peristaltic waves and tumor in the order named.

Strauss relies upon the röntgenologic examination to sharply differentiate the medical from the surgical cases according to the degree of gastric retention. LeWald [21] also expresses confidence in the diagnostic value of the Röntgen-rays. Downes,[22] however, considers the examination unnecessary and in some instances harmful except occasionally. Gerstley and Wilhelmi[23] state that the röntgenologic examination tends to increase the vomiting. Projectile vomiting occurred in one of my little patients soon after the barium meal but not before two radiographs had been made by Dr. S. C. Davidson. Richter [24] warns us that the Röntgen-ray should not be relied upon to determine the patency of the pylorus. We cannot exclude the diagnosis of hypertrophic stenosis on the basis of the passage of bismuth. In two cases this error was made and operation advised against. The diagnosis was confirmed in one instance at necropsy and in the other at a late operation which failed to save the baby.

Richter contends that the Röntgen-ray dependably indicates the rate of emptying time of the stomach.

However, the great diagnostic value of the röntgenologic examination is demonstrated by the accompanying illustration and by Doctor Davidson's description of his findings.

Many pediatricians contend that the gastric retention is sufficiently confirmatory and may be accurately gauged by the withdrawal of a measured test-meal.

Diagnosis is sometimes difficult. The early symptoms are not always characteristic. Every change of food may be followed by a temporary cessation of vomiting and the physician naturally infers that he is dealing merely

with a feeding problem. A patient of mine, for example, developed normally for a month. Then the mother's milk failed and coincident with the weaning vomiting began. The vomiting continued in spite of dietetic changes. Soon after the characteristic symptoms appeared the Rammstedt operation was performed when the baby was seven weeks old.

Medical treatment rests upon the theory that the pyloric obstruction is spasmatic rather than mechanical. Sauer [25] in 1918 suggested the use of thick cereal feeding. Under this treatment the vomiting soon stopped, but usually the peristaltic waves and the tumor when palpated persisted for weeks or months. Sauer [26] continues the cereal feeding for from five to eight weeks. Then if vomiting is not provoked by the thin food, the child will tolerate a milk mixture without much trouble in spite of the peristalic waves and the palpable tumor. Twenty-eight patients were treated by this method with one sudden death. During the same period seven patients had surgical treatment. Two of them died. Porter treated ten patients with the thick formula and all of them recovered.

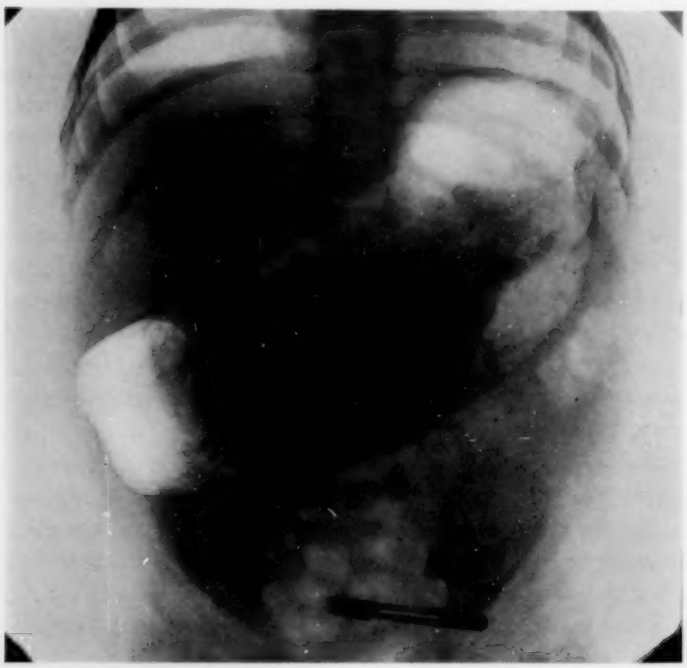

FIG. 1.—STOMACH: Fluoroscopic and radiographic examinations. A thin solution of malted milk containing barium sulphate was administered. The child could only retain about one ounce. The solution was observed to drop into what appeared to be a dilated stomach. The radiographs demonstrated a stomach dilated to more than twice the normal size. The outlines of the lesser and greater curvatures were quite regular, the pyloric end of the stomach ending up rather bluntly but evenly. The pylorus was not outlined nor was the duodenum demonstrated. No barium was observed to enter the small intestine. Conclusion: There is presented a markedly dilated stomach which is secondary to some form of benign stenosis of the pylorus.

Haas [27] in 1919 first advocated the administration of atropin. The flushing, midriasis, fever, dryness of the lips and mouth, inability to secrete tears, irritability, quick, jerky movements, pallor and drowsiness induced by the drug are harmless and transitory. The duration of this treatment, according to Haas, varied from a few weeks to most of the first year. Haas [28] reported the treatment of 40 patients by this method. One patient died suddenly and one came to operation. The others recovered, although surgical treatment had been advised for over 20 per cent. of them.

Sedgwick [29] fed breast milk to 44 infants and lost but one. Heubner [30] applied the same treatment to 21 infants with a mortality of 22.9 per cent. Ibrahim [31] collected from the German literature reports of eighty-three patients treated medically with a mortality of 22.9 per cent. Thomson cured twenty-six of his fifty-four patients and Parsons and Barling [32] cured five of their thirty-six patients.

Regarding the method, Thomson states that we cannot expect by medical treatment to greatly hasten the opening of the passage. We may be able to relieve it, however, just sufficiently to keep the child alive in spite of the continuation of the obstruction until spontaneous recovery has had time to occur.

Still maintains that the influence of spasm is indicated by the fact that food occasionally passes. According to Richter, however, the tumor mass mechanically blocks the lumen, but it is tunnelled by an intact mucosa, the closure of which is exactly analogous to the blocking of the urethra by a large prostate. As increasing tension in the urinary bladder may produce an overflow incontinence, so stomach contents may be forced through.

MacDonald [33] contends that the pyloric tumor is permanent. He stigmatizes medical treatment as a laborious attempt to coax an already dilating stomach to undergo an hypertrophy sufficient to overcome the pyloric stenosis. And Faber [34] reiterates that congenital stenosis, if not relieved in time, inevitably leads to enlargement of the stomach, the effects of which may be felt all through life.

Thomson, on the other hand, found that none of the thirty-three patients followed up after medical treatment showed any signs of serious gastric derangement. The ages of these children at the time of the investigation varied from ten months to sixteen years and nine months. Recovery was apparently complete. Holt agrees that patients treated medically usually show no symptoms after the first year, but adds that possibly the hypertrophy may be the basis of pyloric obstruction in later life.

Veeder, Clopton and Mills [35] studied eight children röntgenologically. Four had been subjected to operation and four had been treated medically. In the group were sister and brother. The sister had been treated medically and had a very difficult first year. She had never been a strong and healthy child and has about the same physical development as her brother two years younger, who had had a Rammstedt operation. The röntgenologic examination revealed no abnormality in either child. The little girl evidently was a victim of arrested development. The investigators have heard of no similar instance.

Analysis of the medical treatment of infantile pyloric stenosis reveals that in one series in which all the patients recovered, several of the cases lacked some of the characteristic symptoms.

Bolling avers that no medical treatment that involves taking a breast-fed baby off the breast is admissable. Still believes that the possibility of retaining the breast feedings should decide in favor of immediate operation rather than risk the loss of the mother's milk through her prolonged anxiety

during the medical treatment. And Goldbloom and Spence [36] have learned that the mortality from pyloric stenosis among the artificially fed infants is three times that of the breast fed. Yet some of the pediatricians deliberately take the infant from the mother. Porter [37] states that one baby vomited the breast milk but not the thick feeding. The infant was, therefore, gradually taken from the breast.

The prolonged period of disability incident to medical treatment, the tediousness of the thick feeding and the alarming toxic symptoms of atropin militate against these methods. They fail from the economic standpoint and from the viewpoint of the anxious mother. Also the danger of intercurrent diseases constantly threatens. And Kerley [38] reminds us that sudden and unexpected deaths in the palliatively treated cases are not uncommon, possibly from acidosis.

Finally, the pyloric hyperplasia remains. Richter states in this connection that the mere permanency of the tumor is not a surgical argument. Since the mass is not a neoplasm but merely a muscular hypertrophy, it should ultimately disappear. Operation is indicated, however, because the obstruction does not disappear quickly enough.

The duration of the hypertrophy is uncertain. Lewis and Grulee [39] describe the obstructive tumor as observed at necropsy eight months after a gastro-jejunostomy. From the duodenal side the enlargement projected into the lumen of the bowel as the uterine cervix projects into the vagina. The lumen of the pylorus viewed from the stomach side was greatly reduced in size and surrounded by a rigid wall. A fine probe could be passed through the opening. Holt saw the tumor apparently unchanged four years and seven months after a gastro-jejunostomy. Shaw [40] reported that necropsy on a boy at five years showed the pylorus to be a hard resisting mass of hypertrophied tissue. The canal would admit a probe under pressure, but was absolutely tight to all fluids owing to a swollen and twisted condition of the mucous membrane. Walton [41] and others report similar findings.

Heubner [42] has observed symptoms of pyloric obstruction persisting into the third, fourth and seventh years of life. Truesdale [43] advances the likely hypothesis that "If this congenital deformity is one of degree, there follows the natural assumption that an individual who has had gastric discomforts so long as he can remember may have a partial stenosis that is congenital." Two of Truesdale's specimens "showed a fusiform overgrowth of the pyloric muscle corresponding to the arrangment of muscle fibres in the congenitally hypertrophied pyloric muscle. In one of these cases the history of gastric disturbance dated to a period as remote as the patient could remember."

Under the title "Congenital Hypertrophic Pyloric Stenosis in the Adult," Oliver [44] convincingly reported the history, operative findings and result in a man fifty-one years old. The patient had suffered from stomach trouble all his life. His mother stated that when he was an infant she "had a terrible time raising him. Then and later he was undernourished, vomited fre-

quently and had periodic attacks of biliousness." The symptomatology, the physical findings, the observations at operation, the operation itself (Rammstedt procedure) and the outcome were suggestive. They resembled strikingly pyloric stenosis and the relief from timely surgery as usually observed during early infancy.

The surgical treatment of infantile pyloric stenosis is based upon the observation of mechanical obstruction at the operation. No one who has seen the œdematous tumor *in situ*, felt its extreme hardness, perceived its remarkable thickness when severed and the bulging of the mucosa between the cut muscle fibres can doubt the mechanical nature of the obstruction.

Downes in 1916 stated that "Œdema in varying degrees involving the pylorus and pyloric region of the stomach was present in all cases. We believe the presence of this œdema is the factor which determines the definite onset of symptoms." Sparrow,[45] Haggard and Wall [46] quote this opinion without comment. Lewisohn and Morrison [47] contend that a malformation exists at birth with later œdema. And Palmer and Barr [48] agree that the œdema plus the hyperplasia without spasm causes the obstruction. All surgeons observe the œdema but few evaluate it.

The mechanism of the obstruction is explained by Downes in the statement that "the effort necessary to force food through the narrowed and elongated pyloric lumen produces circulatory disturbances resulting in œdema. As the food increases in amount the muscular effort becomes greater and the lumen narrows down. Finally at the tenth day or a little later it becomes more or less completely obstructed."

In 1916, Downes subjected the bad risks to immediate emergency operation. Now, however, Bolling emphasizes the value of hypodermoclysis and transfusion for these patients delaying operation for from twenty-four to seventy-two hours. The mortality from collapse within seventy-two hours after operation has thus been materially reduced.

Regarding the infant as a surgical risk, an editorial writer [49] reminds us that "despite the drawbacks incident to diminutive proportions and other graver reactions the infants nevertheless recuperate after laparotomies much better than adults. The child, for example, has a greater margin of reserve than the adult, his tissues are more capable of adaptation of function and more vigorous in repair. Also, his blood-making system exhibits greater activity and his comparatively undifferentiated nervous system is less mobile and less unstable.

"Why then should Rammstedt's operation possess such a high mortality rate? The chief reason is that the infant with hypertrophic stenosis is a starved animal with lowered resistance to trauma, to shock and to infection of the intestinal mucosa. The operation is often a last resort after medical measures have failed.

"The factors of success in operating upon young children are above all gentleness in the manipulation of their delicate tissues; speed without roughness; the avoidance of blood loss and finally the minimum intra-abdominal

trauma and exposure of the viscera with conservation of the body heat." A properly executed Rammstedt operation meets these requirements.

Goldbloom and Spence concluded from their analysis of 163 cases that the prognosis in the operated cases of infantile pyloric stenosis depended upon four factors. First, if the duration of the symptoms, chiefly vomiting prior to operation, was under four weeks the mortality was 13.4 per cent., if over four weeks 35.42 per cent. Second, if the infants were breast-fed 11.3 per cent. succumbed, if artificially fed 35 per cent. died. Third, if the weight was seven pounds or more the mortality was 8.7 per cent., if under seven pounds the mortality increased to 28 per cent. And fourth, the mortality of the entire group, whether breast or artificially fed, increased directly with the percentage of the weight loss. If the loss was less than 20 per cent. of the best weight, the mortality was 6.58 per cent. If the loss was 20 per cent. or more, the mortality rose to 37.25 per cent.

The Rammstedt procedure need be discussed merely as regards the technical errors and the complications. Chief of the former is the opening of the duodenum. Many surgeons report this accident. The recent practice of bluntly dividing the deeper muscle fibres, however, is relatively safe. Gray and Pirie maintain that the obstruction can be relieved without dividing the pylorus far enough on the duodenum to enter the lumen. The division should stop just short of the point where the white, avascular coat merges into the normal vascular structure of the duodenum. Palmer concurs in this opinion. Anyhow, the closed perforation should usually be innocuous. One wonders, however, if some of the rare deaths from unexplained peritonitis may not have been due to undiscovered minute openings.

Serious or fatal hemorrhage may occur from unsecured vessels in the pyloric incision or in the abdominal wound. Rarely the bleeding results from true hæmophilia. Adequate hæmostasis as described by Bolling and preoperative precaution should largely obviate these dangers.

Material infection of the incision, according to Bolling, is unusual. If omphalitis exists, however, infection of the wound is almost inevitable. Complete separation of the abdominal wound has been observed by Apt.[50] Provided layer suturing has been done, the failure of union indicates extreme debility. Lewis [51] in this connection warns us against an incision through the linea alba. Occasionally a ventral hernia develops which may or may not require subsequent repair. A few instances of adhesions and intestinal obstruction have been reported. Operative trauma perhaps has been responsible for these. Deaths from gastro-enteritis and sudden unexplained deaths usually follow late operations.

The importance of the post-operative care is uniformly stressed, particularly as regards the feeding of breast milk. Post-operative vomiting is not uncommon and the amount of the feedings must be increased cautiously. The coöperation of the pediatrician is essential. The sutures are removed on the tenth post-operative day. Then in the absence of surgical complications the care of the infant devolves upon the pediatrician. The dietetic

disturbances outlast the pyloric obstruction. The duration of hospital care after the operation varies from two to three weeks.

Regarding healing, Ransahoff and Wolley [52] report necropsy findings seven months after a Rammstedt operation. There was no herniation at the site of the pyloric incision. A smooth, linear, fibrous scar joined the cut muscle fibres. The tumor was gone. The muscle layer was possibly a little better developed than normal. Wollstein reports nearly identical findings.

The operative mortality during recent years has steadily decreased. Bolling, for example, reports the results of 454 Rammstedt operations performed since 1914 by Downes and himself. The mortality for the first 175 cases in this series was 17.1 per cent., whereas the mortality among the last 130 patients was only 8.5 per cent. The mortality for the entire series was nearly 15 per cent. Poynton and Higgins report twenty cases treated during 1920 and 1921 with an operative mortality of just under 45 per cent. The surgical mortality for the thirty-five patients who were treated during 1922 and 1923, however, was less than 15 per cent. The improvement was due to earlier operations. Mixter [53] reports 195 operations during the past ten years with a mortality of 9.5 per cent. Strauss,[54] in 1920, reported 103 operations with three deaths. Palmer, in 1922, reported thirty-nine operations with two deaths. Porter, in 1919, reported twenty-two operations with two deaths, Hill, in 1920, reported twenty-two operations with one death. And Green and Sidbury, in 1919, and Lewis, in 1920, reported five operations with no mortality.

On the other hand, Parsons and Barling, in 1923, reported fifty Rammstedt operations with twenty-four deaths. Such a mortality implies delayed surgery. Indeed, Parsons and Barling estimate that early operations would be curative in at least 80 per cent. of the cases.

Opinions regarding treatment vary. Gerstley and Wilhelmi state that in ten years they have not seen a case that required operation. Haas avers that surgery should be a rarity and only after a trial of atropin. Sauer observes that good results are often obtained without surgery. He voices the dilemma of the pediatrician, however, in the statement that operation soon after the diagnosis is made may be an unnecessary operation. On the other hand, persistence in unsuccessful feeding may increase the surgical risk. Thomson believes that medical treatment cannot greatly hasten the opening of the passage. Eventually the pylorus will open spontaneously and the child recover completely provided he does not die in the process. If the pyloric lumen has been efficiently opened up by a surgical operation, however, the gain in weight usually sets in rapidly. Kerley maintains that low mortality in pyloric stenosis depends upon early diagnosis and immediate operation. This does not mean, however, that a child with a palpable tumor cannot recover without an operation. Haggard affirms that only the very mild cases without contractions of the tumor and with only partial retention should have medical treatment. All others should be treated by operation just as any other mechanical obstruction in the alimentary canal. Parsons and Barling hold

that Rammstedt's operation preceded and followed by a careful medical régime offers the best means of reducing the high mortality of the disease. Downes noted in 1920 that increasing numbers of babies were being referred by the pediatricians for operation. And Sparrow thinks that we are undergoing the same transitional stage of expectant treatment in this disease as we have been through in appendicitis and gall-stones. Observers agree that sudden, unexplained deaths occur under both medical and surgical treatment in the prolonged cases.

SUMMARY

Since Beardsley first described infantile pyloric stenosis in 1788, conjecture has been rife regarding the etiology. Some theorists maintain that the enlargement is a work hypertrophy resulting from spasm. Most observers, however, contend that the hypertrophy is a congenital malformation with spasm and œdema added. The symptomatology is well known and characteristic.

The pathology consists of simple hypertrophy of the circular muscle fibres. Some observers palpate the tumor usually or always, but to others such recognition is often impossible. Some believe that the diagnosis hinges upon feeling the tumor, but others consider its palpation unessential. The Röntgen-ray sheds brilliant diagnostic light. Debilitated infants, however, are not fit subjects for the examination. And the patency of the pylorus cannot always be accurately determined. Gastric retention may also be gauged by the test meal. Uncharacteristic early symptoms sometimes delay the diagnosis.

Medical treatment rests upon the theory that the obstruction is due to spasm. Recent medical methods appear successful in some hands, but the critics contend that the obstruction remains and must be slowly overcome. Nevertheless, some observers maintain that the infants suffer no permanent harm. Arrested development was noted, however, in one instance. A statistical comparison of the results of medical and surgical treatment is difficult since cases lacking some of the characteristic symptoms are included in the medical series. Also, surgery is often the last resort. The removal of the infant from the breast, the prolonged period of disability, the tediousness of the thick feeding and the alarming toxic symptoms of atropin militate against medical treatment. Also, the danger from intercurrent infections constantly threatens and sudden, unexpected deaths sometimes occur.

The duration of the hypertrophy too is uncertain. Necropsy has revealed the obstructing tumor in a boy five years old. Symptoms of pyloric obstruction have been observed persisting into the third, fourth and seventh years of life. And pyloric stenosis, apparently congenital, was noted at operation in a man fifty-one years old.

The surgical treatment is based upon the observation of mechanical obstruction at operation. The effort necessary to force food through the narrowed and elongated pyloric lumen results in œdema. The œdema necessitates greater effort and this increased effort perpetuates the œdema.

Finally obstruction becomes more or less complete. Pre-operative preparation is essential for the bad risks. The surgical accidents are opening the duodenum and hemorrhage. Both are preventable. Infection of the incision ordinarily is rare. In the presence of omphalitis, however, it is practically inevitable. Complete separation of the properly placed abdominal incision can be prevented by layer suturing, except in the extremely debilitated infants. The post-operative care is uniformly stressed, particularly as regards the feeding of breast milk. The coöperation of the pediatrician is essential.

In general the infant recuperates after laparotomies much better than the adult. Successful surgery upon babies, however, demands gentleness, speed, the avoidance of blood loss and of exposure of the viscera and the conservation of the body heat. A properly executed Rammstedt operation meets these requirements. The prognosis after the Rammstedt procedure depends, also, upon the duration of the symptoms, whether or not the infant was breast fed, the weight at the time of operation and the percentage of the weight loss. The Rammstedt operation is followed by smooth healing of the pyloric incision without herniation of the mucosa. The tumor disappears.

Opinions regarding treatment differ. Some pediatricians contend that operation is seldom if ever necessary. On the other hand, one observer asserts that we are undergoing the same transitional stage of expectant treatment in this disease as we have been through in appendicitis and gall-stones. Sudden deaths occur with any type of treatment in the prolonged cases. The mortality after the Rammstedt operation is still too high, chiefly because infants with pyloric stenosis have lowered resistance to trauma, to shock and to intestinal infections. And operation is often a last resort. Nevertheless, in one large series of cases the surgical mortality has been reduced 50 per cent. since 1920.

CONCLUSION

Timely operations for the relief of infantile pyloric stenosis conducted under the recent improved pre-operative and post-operative care and operative technic will decrease the surgical mortality everywhere. Coincidentally, the general death rate of the disease will fall.

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NOTE ON BENIGN TUMORS OF THE DUODENUM

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The senior author of this paper in December, 1919, in a paper entitled "Intussusception Resulting from Benign Tumor of the Intestine," reported three cases of benign tumor of the small intestine producing intussusception. These cases occurred in children from five to sixteen years of age. One was a fibroma, the other two adenoma. Attention was also called to the few cases of adenoma that had been reported in the literature. Since the appearance of that article two adenomata of the duodenum in adults have come under our observation. We feel that the occurrence of adenoma of the duodenum in the adult is sufficiently uncommon to justify the report of the two following cases.

Case I.—B. M., colored, male, age sixty-three years, farmer. Entered St. Philip's Hospital for colored patients on the service of Dr. A. Murat Willis on August 1, 1923. Discharged September 4, 1923.

The patient dated onset of trouble to two months previous to admission. A dull and not severe pain in the epigastrium called the patient's attention to a hard "knot," the size of a fist, in the region of the umbilicus. The pain seemed to be localized, as a rule, to this "knot." At the same time there would be some nausea. The nausea, the patient stated, was worse when the stomach was empty. Since the onset he had vomited twice—a clear, mucoid fluid containing no blood or food. Since the onset of his trouble there had been a gradual loss of appetite and a loss of fifteen pounds of weight. Bowels were always regular but of late he was constipated and troubled with gas. The patient stated that the knot seemed to be growing smaller, but the "misery" in the abdomen was not decreasing any. No attacks of diarrhœa. Never noticed any blood in the stools. Never been jaundiced. The patient had no other symptoms except failing vision in the left eye.

Past History.—Measles, mumps, pertussis, varicella. There was a history also of once having had an illness which resembled typhoid fever. No operations. Gonorrhœa when fifteen years old; later inguinal adenitis with surgical drainage and healing. No history of a chancre. Has partaken of alcohol moderately. No tobacco. Marital history unimportant. The family history was unimportant.

Physical Examination.—Well-built and well-preserved colored male, in no acute pain or discomfort. The eyes showed no jaundice. There was a pterygium on the nasal side of each eye; an incipient cataract on the right, and a nearly mature cataract on the left. Pupils reacted well. The teeth and gums showed considerable caries and marked gingivitis. The lungs were clear. The heart was normal in size, rate and rhythm. The arteries showed general sclerosis, compatible with the patient's age. The blood-pressure was 126 mm. systolic and 70 mm. diastolic. The abdomen appeared sunken below the costal margins and iliac crests. No visible peristalsis or mass. No hernia. On raising

the head slight diastasis of the recti muscles was evident. A small, firm nodule the size of a pecan nut was visible and palpable in the left upper quadrant near the costal margin. This nodule appeared to be in the abdominal wall and freely movable. The abdominal muscles showed no rigidity. The spleen, liver and kidneys were not palpable. No tenderness could be elicited anywhere. The aortic pulsation could be felt to the left of the umbilicus. When put on his hands and knees and in the knee-chest position no mass could be felt.

The spine appeared entirely normal. Knee-kicks were obtainable on reinforcement. On the left thigh, lateral surface, there was a rather soft, subcutaneous tumor the size of a marble. This was freely movable and appeared to be analogous to the tumor felt in the abdominal wall, except that it appeared to be not as firm.

Rectal examination revealed no fissure or fistula, no hemorrhoid or tabs. The prostate seemed a little large but of normal consistency. The lateral lobes could be well outlined. No masses felt

The urine was negative. The blood was normal in all respects. The blood Wassermann was negative.

Gastro-intestinal X-ray examination showed a stomach of "J" shape reaching the promontory of the sacrum in upright position with the appearance of an annular filling defect close to the pylorus. A well-filled duodenal bulb could not be obtained and this structure seemed to be irregular. At the six-hour period no evidence of obstruction or delay was observed. This examination seemed to indicate that there was a lesion involving the pyloric portion of the stomach, malignancy, adhesions or scar tissue being suggested as a cause.

On August 3 an exploratory laparotomy was done. A large polypoid tumor was found to be present in the duodenum. This tumor was attached by a pedicle one inch long (2.5 cm.) to the posterior wall of the duodenum, the place of attachment of the pedicle being about one inch (2.5 cm.) distal to the pyloric sphincter. On manipulation the tumor could be forced through the pyloric sphincter. Through the right rectus incision an incision was made in the duodenum about 2 inches (5 cm.) distal to the pyloric sphincter, exposing the tumor attached to the posterior wall of the duodenum by its pedicle. The tumor was removed, first tying off the pedicle. The post-operative course was uneventful.

On August 22 the cataract was removed from the left eye. On September 4 the patient was discharged.

Gross Description.—The tumor was much larger when felt *in situ* than when weighed after removal. In the gut it appeared to be the size of a small fist. After removal it weighed 12 gms. It felt firm—the surface had a lobulated appearance, the individual lobes appearing smooth. After removal, the pedicle measured (1.5 cm.) long. The tumor measured 3.5 cm. x 3 cm. x 2 cm. On section the lobulated appearance noted before was seen to continue in well-defined lobes.

Microscopic Description.—The tumor was made up of the structural element of Brunner's glands. Acini were numerous, the arrangement being irregular. The cells were single layers, perhaps larger than normal, and contained within the basement membrane. The mass was covered with mucosa. No mitoses seen. Autolysis was rapid. Pathological diagnosis: Adenoma.

CASE II.—Mrs. L. D., white, female, housewife, age sixty-two. Entered the Johnston-Willis Hospital on the service of Drs. A. Murat Willis and Frank S. Johns, August 27, 1924. Discharged October 16, 1924.

Patients chief complaint was pain in upper abdomen and jaundice.

Family history was negative except one sister had tuberculosis. Patient had the usual childhood diseases, had "rheumatism" of five months' duration ten years ago, and

a slight attack of influenza two years ago. She had had no operation. Her cardio-respiratory history was negative except slight dyspnœa on exertion and some œdema of extremities. Chronic constipation and nocturia were symptoms. Had been bothered with hemorrhoids. Married forty-six years; had six children. Menopause twenty years ago.

Her present illness began on January 1, 1924, when patient suffered a severe colicky pain in her upper abdomen, more to the right, radiating to her neck and shoulders. At that time she had a chill accompanied by nausea vomiting and fever. This lasted about twenty-four hours. About a week later she suffered a similar attack and these attacks were repeated at about monthly intervals until July when the pain and discomfort became continuous and she noticed a yellow tinge of her skin which persisted. During this time she had almost continuously a sensation of heaviness in the pit of her stomach and especially after meals. Her appetite was fair. She suffered with constipation, which, if not corrected, aggravated the above symptoms.

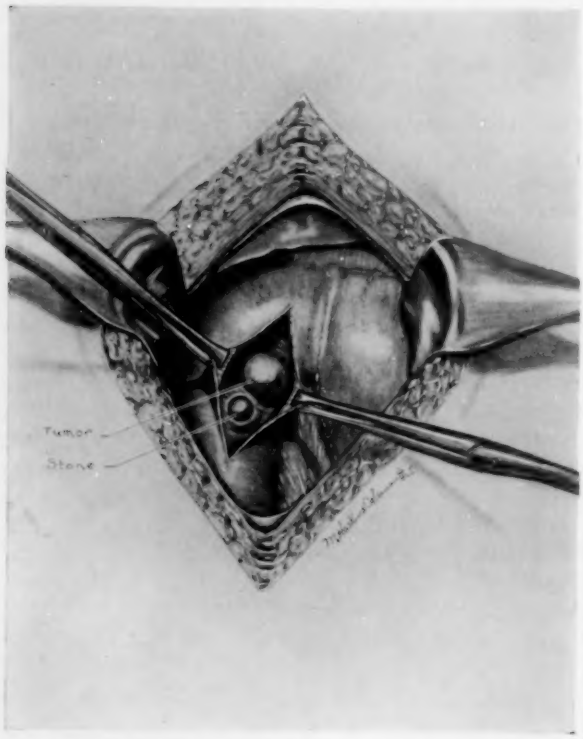

FIG. 1.—Case II. Drawing showing appearance of tumor at operation and stone presenting at opening of common duct into the duodenum.

Physical examination revealed a white cachectic female about sixty years old with deeply jaundiced scleræ and skin. Teeth were false, tonsils atrophied, pupils reacted to light and accommodation. Thorax very thin, ribs prominent, breasts atrophic, flabby, and contained no tumors. Lungs negative. Cardiac impulse in fifth interspace, rate regular, no arrhythmia or murmurs. Blood-pressure, 115/70. Abdomen somewhat distended and tympanitic. Slight rigidity and marked tenderness in upper right quadrant. Gall-bladder could not be palpated. No hernia or abdominal masses. Spine flexible and not tender. Extremities were negative and reflexes were non-pathologic. Hemorrhoids present.

Laboratory reported hæmoglobin 52 per cent., red cell count 3,230,000, leucocytes 10,600, of which 65 per cent. were polymorphonuclears, 18 per cent. small mononuclears and 16 per cent. eosinophiles. Coagulation time three minutes and Wassermann negative. Urinalysis showed a trace of albumin, hyaline and granular casts.

Diagnosis: (1) Stone in common duct. (2) Chronic nephritis. (3) External hemorrhoids.

Patient was put on a pre-operative treatment of rest in bed, regulation of bowels, proper diet, hydrotherapy, and calcium lactate gr. $\overline{xx}$ t.i.d. for a week.

September 19 through a right rectus incision a biliary calculus the size of an English walnut could be palpated behind the head of the pancreas at the lower end

of the common duct. In addition to this a small movable mass could be felt within the lumen of the duodenum.

As the stone in the common duct seemed impacted in the ampulla of Vater it was thought best owing to the presence of the tumor within the duodenum, to do a trans-duodenal removal of the stone, and in this way also make the tumor accessible.

On opening the duodenum a small pedunculated tumor about the size of a filbert could be seen attached to the duodenal wall about a quarter of an inch above the orifice of the common duct. A small portion of the stone could be seen presenting at the mouth of the duct. (Fig. 1.) By stretching the duct the stone was easily removed. The pedicle of the tumor was then ligated and the tumor removed. The incision in the duodenum was closed with three rows of catgut sutures, and the abdominal wound closed without drainage.

Patient reacted well, her jaundice gradually disappeared and was entirely absent when discharged three weeks later.

Pathologic report of duodenal tumor: "Body of tumor consists of fibrous tissue and blood-vessels. There are patches of round-cell infiltration. The surface is covered by simple columnar epithelium arranged as gland tissue." Diagnosis: Adenoma.

PANCREATIC LITHIASIS*

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Sistrunk, in 1921, reported four cases of pancreatic stone in which operation had been performed at the Mayo Clinic, and discussed some of the etiologic factors of the disease, its symptoms, the surgical aspects, and apparent association with diabetes, and the physical properties of the stones. Seeger, in 1925, reported an extensive search of the literature in which he found only 100 cases, one of which was his own. He reviewed the literature and analyzed the symptoms in twenty-two cases.

Pain was of a variable character, constant, intermittent or colicky, with radiation in various directions. Glycosuria occurred only twice, and because others had found it more frequently, he considered it a late complication. Urgent early morning diarrhœa was sometimes encountered with a fatty pancreatic type of stool. Jaundice was not uncommon. He emphasized the difficulty in making a diagnosis even after exploration. In three cases the Röntgen-ray revealed these stones of calcium carbonate.

The articles by Sistrunk and Seeger cover the subject thoroughly. Seeger abstracted twenty-two case histories which included Sistrunk's four cases. A summary of the abstract is as follows:

Pain was not mentioned in three cases, was noted as absent in two, mentioned in six, called severe in ten, and radiated to the back in nine. The pain was situated in the epigastrium or hypochondriac areas with one exception, when it occurred in the left lateral area with downward radiation. Jaundice was not spoken of in six, absent in nine, and was noted in seven; in three cases it was severe.

Gall-stones were not mentioned in five cases, were noted absent in fourteen, and present in three. Glycosuria was present in two cases, was noted absent in fifteen, and not mentioned in five. Loss of weight was not mentioned in fourteen cases; moderate loss was noted in five, and marked loss in three. Vomiting occurred in two cases. Diarrhœa of pancreatic type was not mentioned in fourteen cases, was absent in four, and present in four. Since Sistrunk's report there have been four cases of pancreatic stone demonstrated at operation at the Mayo Clinic. There were five other cases in which pancreatic stone was suspected clinically but not confirmed by operation or Röntgen-ray. These cannot be considered as cases of pancreatic stone.

REPORT OF CASES

Case I.—A school girl, aged twenty, came to the Mayo Clinic in May, 1925, because of weakness, palpitation, and shortness of breath, which had lasted three years. She had had influenza in 1920 and repeated sore throat. Her sister had heart disease. In

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1922, the patient noticed a rapid action of the heart. Tonsillectomy was performed, and she was somewhat better, but the palpitation returned. The thyroid gland was partially resected in 1923. Weakness kept her in bed for five months after this operation. The pulse rate diminished somewhat after that but any exertion brought on palpitation and dyspnœa. In 1924, she was put on digitalis and continued this medication until the time of admission to the clinic. There was no history of pulmonary disease, or œdema. She had complained of pain in the joints and muscles for two months before admission.

At the time of admission the systolic blood pressure was 102 and the diastolic 76, the pulse rate 84, and the temperature 99.2. The precordium was retracted and there was a systolic murmur. The urine and blood were normal. The blood count was normal and the blood Wassermann reaction negative. The gastric content was normal and röntgenologic examinations of the chest and stomach were negative. The basal metabolic rate varied between +1 and +8. The impression was that cardiac neurosis was the predominant symptom. This opinion was concurred in by two consulting physicians. While under observation the patient developed periodic and increasingly severe pain high in the epigastrium, with vomiting. The leukocytes numbered 19,600. The initial attack was preceded by slight pain and soreness in the upper abdomen for two days. The high situation of the pain, with a tendency to locate in the right chest, and between the shoulder blades, pointed to disease of the gall-bladder. The temperature was normal. June 2, tenderness was noted at McBurney's point, and again on June 5. The temperature was 98°. Operation on the appendix was advised. No jaundice occurred. June 12 the abdomen was explored through the right rectus. The appendix appeared to be quite normal. A tumor, 6 cm. in diameter, was found in the transverse mesocolon at a point about midway between the middle of the transverse colon and the hepatic flexure. The tumor did not appear to be connected with the bowel. When an attempt was made to remove a portion of it for microscopic examination, it shelled out easily. It was traced back toward the head of the pancreas to which it seemed to be attached. It was suspected that the long neck which ran back toward the pancreas

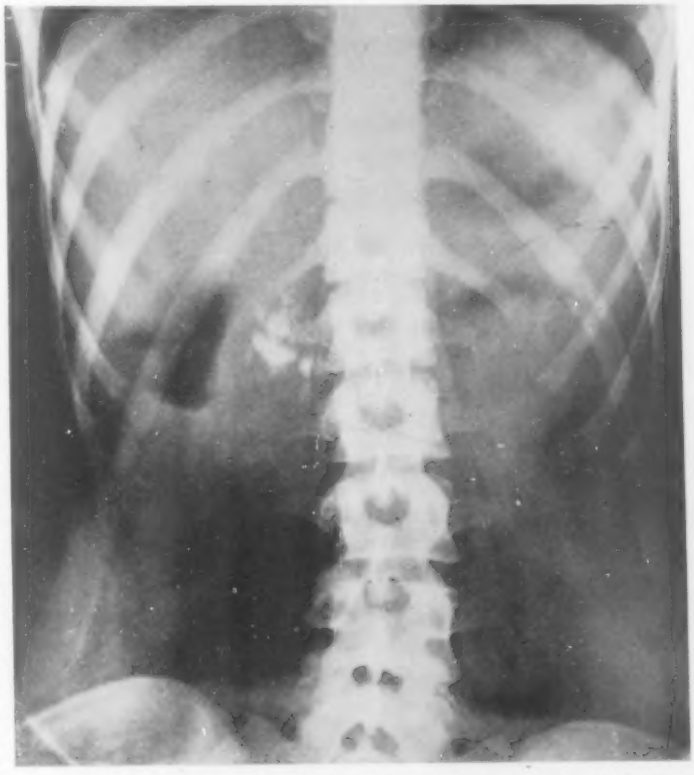

FIG. 1.—Multiple shadows to the right of the first lumbar vertebra, believed to be caused by stones in the pancreas.

was pancreatic tissue. A specimen was removed and pronounced pancreatic tissue by the pathologist. The mass was then looked on as being a possible accessory pancreas. The long neck was cut off at a point corresponding to the head of a normal pancreas. The patient apparently had definite pancreatitis. The pancreas was hard and nodular, but small. The tissue removed was an elongated mass, with a globular end, made up of pancreatic tissue and ducts, filled with many pancreatic stones, the largest 4 mm. in diameter, and the smallest like sand. There was a small cyst in the globular end of the mass, which also contained pancreatic stones.

Just before operation the patient's temperature had suddenly risen to 101°, and following operation it was 102.5°. The temperature was normal again on the third day after operation. There was no record of pyrexia during the next three weeks. After that spells occurred occasionally, with a temperature of 99.6°, median abdominal soreness, no appetite, and mild pain in the back. There was no jaundice or diarrhœa. The bowels were costive. In the past, more than at the time of examination in the clinic, the stools had been light colored and greasy-looking. Fats never caused inconvenience and a great deal of cream and butter was eaten. After preparing the patient by withholding food for twelve hours and complete evacuation of the bowels by means of cathartics and enemas, rõntgenograms taken after the operation showed multiple shadows in the right side, opposite the first lumbar vertebra (Fig. 1). Because stones had been found in the accessory pancreas these shadows were attributed to pancreatic calculi.

Case II.—A woman, aged thirty-three, had complained for seven years of a dull soreness in the epigastrium, worse one-half hour after meals, without associated gastric or other symptoms except a low abdominal pain on stooping, which had troubled her for the last three years. There were no irregularities of the bowel. Her weight was normal. The systolic blood pressure was 110, the diastolic 68, and the pulse rate 80. A pelvic tumor was found. The usual test of the urine and blood were negative. An operation for excision of the pelvic tumor and exploration of the upper abdomen was advised. The right tube and dermoid cyst of the right ovary were removed. Stones were palpated in the head of the pancreas. At a second operation cholecystectomy was performed for relief from a moderately severe chronic catarrhal cholecystitis, without stones. The head of the pancreas was full of stones. Only those easily accessible were removed. The immediate post-operative convalescence was normal but there was no record of later events.

Case III.—A man, aged forty-five, had complained of stomach trouble for three years, with a dull aching in the epigastrium occurring from immediately after meals to three hours afterward, not altered by the ingestion of food or soda. He had had trouble constantly since its inception except for occasional periods of one or two days. There was no severe pain or jaundice. Recently, after nausea, he vomited "coffee grounds" and red blood in the early morning. Following gonorrhœa three years before, he had complained of frequent urination and dysuria.

The physical examination was negative except for moderate epigastric and low right abdominal tenderness. The systolic blood pressure was 140, the diastolic 75, and the pulse rate 72. The usual tests of the urine and blood were negative. A deformity of the duodenum was seen by the Röntgen-ray, and ulcer was suspected.

At operation the stomach was found to be enlarged to twice its normal size, but there was no evidence of an ulcer. At the ligaments of Treitz, a calcified, irregular mass 2.5 cm. in diameter was found in contact with the pancreas. The mass appeared to be a calcified gland or coalesced pancreatic stone which had attempted to perforate the pancreas. It was excised. Marked hepatitis was found and cholecystectomy was performed. The hepatitis was of a degree sufficient to explain the gastric hemorrhage. In the pathologic laboratories no final opinion could be expressed and the report was "stony material from region of pancreas; chronic catarrhal cholecystitis; thick dirty bile." The patient convalesced uneventfully.

CASE IV.—A man, aged forty-five, gave a classical history of duodenal ulcer, without any complications, extending back eight years. Aside from mild epigastric tenderness the physical examination was negative. The systolic blood pressure was 154, the diastolic 92, and the pulse rate 72. The usual tests of the blood and urine were negative. Gastric analysis showed a total acidity of 72, free hydrochloric acid 54, and the röntgenogram depicted the ulcer, which was also found at operation. Gastroenterostomy was performed, and a stone 1 cm. in diameter was removed from the lower edge of the body of the pancreas.

The patient has not heen heard from since his dismissal. This pancreatic stone probably caused no symptoms.

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THE RELATION OF TOTAL AND POLYMORPHONUCLEAR LEUCOCYTE COUNTS IN CHRONIC APPENDICITIS

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Recently a study was reported on the clinical significance of the relation of the total and differential leucocyte counts in 309 cases of acute appendicitis,[1] with a discussion of the literature on the subject. At that time, no reference was made to this relationship in chronic appendicitis. The present study is based upon ninety-three cases of so-called (and so classified) chronic appendicitis. Gibson's "standard chart" is again used for the analysis.

To review briefly, Sondern,[2] in 1905, suggested that the degree of leucocytosis indicated the amount of body reaction and the degree of polynucleosis indicated the severity of the pathological process, while the most information could be gained by a relationship ratio between these two. Gibson[3] immediately applied the idea clinically. In his application of Sondern's principles, Gibson devised a "standard chart," on which he could portray the relationship of leucocytosis and polynucleosis. He takes as the normal extreme white count 10,000 and the normal extreme polymorphonuclear percentage as 75. The total white count is charted on the left side of the chart and the percentage of polymorphonuclears on the right side, with a rise of one per cent. in polymorphonuclears with each increase in the total white count of 1000 cells. Hence 10,000 is connected with 75 per cent. by a horizontal line, 15,000 with 80 per cent., 20,000 with 85 per cent., etc. With a proportional increase in these two factors, a horizontal line results; with a low total white count and a high percentage of polymorphonuclears, a rising line; and with a high total count and a low percentage of polymorphonuclears, a falling line. Hence applying Sondern's principle, a rising line means a relatively poorer body resistance with a more severe inflammatory condition, and hence a more guarded prognosis. And conversely, a falling line portrays a proportional good resistance with a less severe infection, and so a better prognosis.

In the analysis of this series, the term "resistance index" is used, expressed in a minus or plus figure. It refers to the disproportion ratio between the leucocytosis and polynucleosis. When there are 10,000 leucocytes and 75 per cent. polymorphonuclears, there is a normal relationship, and these two figures are connected on Gibson's chart by a horizontal line. Connecting a count of 11,000 leucocytes with 75 per cent. polymorphonuclears

gives a falling line, and using 1000 cells as a unit, the resistance index in such an instance is expressed as a minus one. In a count of 10,000 leucocytes and 76 per cent. polymorphonuclears, there is a rising line connecting the two figures, and the resistance index is expressed as plus one.

Present Work.—The aim of this study of the leucocyte counts in chronic appendicitis was to add further evidence to the conclusions made from the study of acute cases: that the best resistance, as indicated by the resistance index, is offered by the individual against the less severe pathological process, and that the greatest aid to be obtained from a preoperative blood count as to indication for operation, is the relationship of the total leucocyte count to the percentage of polymorphonuclears.

The cases studied are classified only as to the microscopical section diagnosis, all of them having shown the clinical picture of so-called chronic appendicitis. The cases presented were chosen from a relatively large number of cases, but for lack of microscopical diagnosis or blood count, complicating conditions, and other reasons, only ninety-three were found satisfactory.

In the ninety-three cases in which total leucocyte counts were made, the average count was 10,513, with extremes of 28,000 and 4000. The differential count as made in 87 of these cases, shows an average of 70.5 per cent. polymorphonuclears, with extremes of 87 and 47 per cent. The lowest average total white count occurred in the cases showing no microscopical pathology, being 8968, and with also the lowest differential count, with 66.5 per cent. polymorphonuclears. The number of cases in each

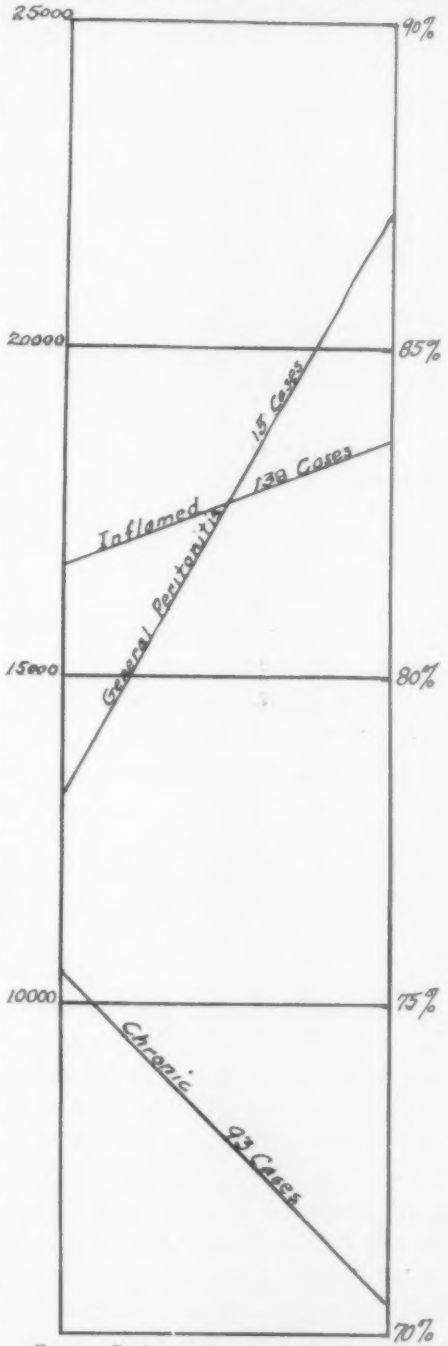

FIG. 1.—Resistance line contrasting chronic appendicitis with acute appendicitis and with general peritonitis.

TABLE I.

Total Leucocyte and Polymorphonuclear Counts in Various Pathological Groups of Chronic Appendicitis.

Pathology	Number of cases with W. B. C. count	Average leucocytosis	Extremes of leucocytosis	Number of cases with differential	Average per cent. polynuclears	Extremes of poly. per cent.	Resistance index
Normal	26	8968	{14400 / 4000}	25	66.5	{81.0 / 54.0}	—7.5
Hyperplastic	17	9694	{12800 / 6000}	17	73.6	{87. / 51.}	—1.0
Catarrhal	9	9648	{15000 / 7000}	7	71.3	{81. / 58.}	—2.3
Atrophic	5	14560	{22000 / 9200}	5	74.6	{83. / 62.}	—4.8
Sclerotic	32	11443	{28000 / 5000}	29	70.9	{87. / 47.}	—5.5
Suppurative	4	13475	{21000 / 8100}	4	74.7	{82. / 60.}	—3.8
Total Cases	93	10513	—	87	70.5	—	—5.0

group (normal, hyperplastic, catarrhal, atrophic, sclerotic, suppurative) with the average total and neutrophilic leucocyte counts is shown in Table I.

The resistance index of the total number of cases is minus five, and when charted shows a steeply falling line. It is shown graphically on the chart, and there can be compared with the rising line in 138 cases of inflamed (acute) appendicitis and the steeply rising line in 15 cases of general peritonitis associated with appendicitis, reported in the previous study. In the 63 cases of chronic appendicitis reported by Pease,[4] the resistance index is a minus 8.9, and in Fowler's [5] 33 cases, it is minus 7.3.

SUMMARY

In acutely inflamed cases, there is a plus resistance index figure, which increases with the severity of the process. The data for chronic cases here presented, shows a minus resistance index figure, which we feel further supports the principle that the total leucocyte count represents the body reaction and the polymorphonuclear count expresses the severity of the pathological process. The ratio between these, as expressed by the resistance index, is a minus figure in cases with chronic pathological changes associated with chronic symptoms clinically, but becomes a plus figure in cases with acute pathological changes, associated with acute symptoms clinically. The figure continues to rise as the severity of the process increases.

The writers wish to express to Dr. H. E. Santee, Director of the Second Surgical Division, their appreciation of the courtesy in affording the opportunity of reporting the above cases.

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TECHNIQUE FOR THE REMOVAL OF HEMORRHOIDS*

By Louis A. Buie, M.D.

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FROM THE SECTION ON PROCTOLOGY OF THE MAYO CLINIC

I WISH to describe an operation for hemorrhoids which is not new or unique, but which eliminates certain undesirable features that are usually associated with this operation.

Preparation of the Patient.—No supper is allowed on the night before the operation, and a dose of castor oil is given. Three hours before the operation the bowel is irrigated with soap suds and warm water, until the water returns unstained, and 2 ounces of witch hazel are injected and allowed to remain until just before the operation, when the fluid is drained through a rectal tube. This is all the pre-operative preparation necessary other than the usual shaving of the perianal skin and the administration of 0.16 grain of morphin sulphate hypodermically.

The patient is placed on the operating table in the Kraske position preliminary to giving a sacral anæsthetic, and allowed to remain in the same position during the operation. A pillow is placed under the pelvis. We are all familiar with the bulging and distortion around the anus produced by the exaggerated lithotomy position, especially when the patient is under the influence of a general anæsthetic. This undesirable feature is eliminated and the position has the advantage over the Sims' position of giving the assistant a more accurate view, and access to, the operative field.

Operation.—The operation is begun by dilating the anus. Divulsion is not resorted to except in cases in which there is anal spasm or actual contraction. Divulsion is unnecessary in performing the average hemorrhoidectomy. It distorts the anus and produces numerous superficial cracks which harbor infection. It also causes much contusion and hemorrhagic extravasation into the muscles. The contention that divulsion puts the anus at rest and thereby excludes the possibility of post-operative pain probably holds good for the first few hours after the operation, but the muscles soon regain sufficient of their former tone to contract again on the raw surfaces. The effects of the over-stretching are, unfortunately, much more enduring and more harmful. The contusion, thrombosis and infection of the numerous superficial cracks, which are caused by the divulsion, produce excessive discomfort, make it necessary to catheterize more frequently, and delay healing materially. Therefore, the anus is dilated just enough to expose the hemorrhoids and to avoid breaking the skin of the anal orifice whenever possible. Through an anoscope a piece of gauze is inserted and pulled through the anus (Fig. 1a). This exposes the hemorrhoids and gives a very accurate idea of the amount of prolapse induced by defecation. This has an important bearing on the amount

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of tissue to be removed. Four retracting clamps are then applied to the anal margin (Fig. 1b). After grasping the hemorrhoid and crushing it with a strong crushing clamp made especially for the purpose, or an ordinary heavy Kelly clamp, a suture is tied at the upper end of the hemorrhoid (Fig. 1c). The excess mucous membrane and veins are cut away and the suturing continued (Fig. 1d). After tying, the ends of the suture are left long. The protrusion externally is then grasped and cut around (Fig. 2a). The veins

FIG. 1.—Exposure and removal of internal hemorrhoids.

are dissected from the sphincter, crushed in a curved clamp, cut away and the suturing continued (Fig. 2b). If the needle is carried too deeply into the muscle, pain and muscle spasm are the result. The wound margins now fall together and no further sutures are necessary (Fig. 2c and d). When there are no external or marginal varicosities the operation is completed by omitting the steps depicted. A strip of 1 inch iodoform gauze, about 3 inches long and in four layers, inserted through an anoscope, completes the operation.

Post-operative Care.—When the patient is returned to his room he is given 0.16 grain of morphin sulphate hypodermically, and from three to five hours later, 30 grains of bromids. A liquid diet is given, and on the day following the operation the care of the wound is begun. The post-operative management is the most important part of the entire procedure, and many troublesome complications are avoided by strict attention to it. On the morning of the second day the dressing is removed and the anal margins cleansed with

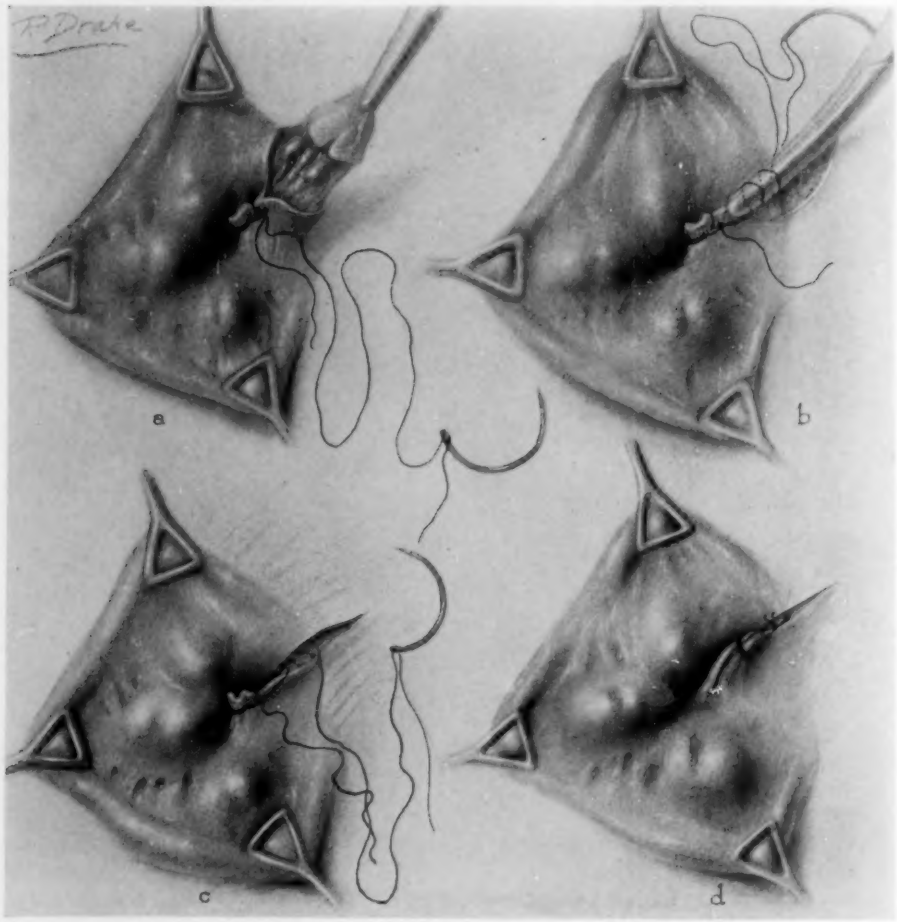

FIG. 2.—Removal of external hemorrhoids.

witch hazel, boric acid, or some other mild antiseptic solution. The margins of the wound are swabbed with small cotton applicators and a dry dressing powder applied. A small piece of cotton or gauze is sufficient to protect the wound. This is done daily for four days and the patient remains in bed. On the night of the fourth day an ounce of mineral oil is given and a general diet ordered. On the next morning the bowel is irrigated with hot water (110°) during which time the iodoform gauze strip comes away. The irrigation should be thorough and continued until the water returns clear. After this

a perforated irrigating tip, 0.5 cm. in diameter, is inserted through the anus, and a 20 c.c. syringe is used to irrigate the wound margins with witch hazel. This is followed by thorough and careful swabbing and drying of the wound, and the application of dry powder. If there is swelling, pain or other evidence of unusual infection, hot fomentations should be applied and changed hourly. On the sixth and seventh days the bowels do not move as a rule, and it is only necessary to irrigate the anus with witch hazel and apply dry dressings. If they should act, however, hot irrigation is carried out, and this procedure should follow every stool for three weeks after the operation, even after the patient has left the physician's care. It is not necessary to give opium to "confine the bowels"; simple instructions to the effect that it is undesirable to have bowel movements during the first four days after operation are usually sufficient.

After the seventh day, proper foods and mineral oil keep the bowels moving daily, and the treatment is the same as that carried out on the fifth day. Digital examination is made occasionally during the second week, and the patient can be dismissed permanently in from twelve to sixteen days. At this time he is instructed to take a hot enema after each stool for a week.

A relatively poor operation can be made to produce a very satisfactory result if the proper care is given to the wounds after the operation is completed. On the other hand, a splendid operation may result disastrously, and frequently does, because no attention is given to the post-operative care. The care of wounds after hemorrhoidectomy, or more accurately, the lack of care of these wounds, is in striking contrast to the vigilance of surgeons in their care of wounds following all other types of surgery. Such distortions as tags and strictures are not due to the removal of too much or too little tissue, or other faulty technic, but they are the result of progressive slough occurring when healing should be uninterrupted.

Physicians are in the habit of minimizing the importance of rectal diseases, and patients are usually told that it is only a simple matter and that they will be up and around in a few days after the removal of hemorrhoids. No wonder there is dissatisfaction at the disillusionment, as days of discomfort drag on into weeks. We should offer more consideration to patients with all rectal complaints. We should examine them early, no matter how trivial the signs. Nowhere is the golden rule more applicable.

BILATERAL DUPLICATION OF RENAL PELVES AND URETERS*

By Henry W. E. Walther, M.D.
of New Orleans, La.

The literature on duplication of the ureters and renal pelves has been thoroughly covered in recent years by the excellent contributions of Mertz,[1] Harpster, Brown and Delcher,[2] and Braasch and Scholl.[3] Mertz rates the frequency of bilateral duplication of ureters and renal pelves as 27 per cent. of all anomalous conditions met with in the upper urinary tract; Braasch places the figure at 6 per cent.; and Harpster gives 10 per cent. This variance Braasch attributes to the failure on the part of the profession to report these interesting abnormalities.

Of instances of bilateral duplication of ureters and renal pelves, Harpster was able to collect 40 from the literature; Braasch added 9; Eisendrath and Phifer [4] cite one case; and the patient herewith reported brings the total to 51. Few cases have been diagnosed pre-operatively. Before the use of the cystoscope and the X-ray the reason was obvious. But to-day the failure to detect these anomalies must rest with the cystoscopist. Too hurried an examination of the bladder mucosa, the failure to employ indigocarmine where double ureteral ostia are suspected and the omission of urograms undoubtedly account for many of these cases going unrecognized. The condition is of interest clinically because of the frequent pathology encountered. In these cases it is not uncommon to find infected urine from only one of the numerous ureteral orifices, the others giving urine free of pus and bacteria.

To the literature already accumulated we add the following history of a recent case under our observation.

Mrs. M. W., age sixty-five, native of Louisiana, seen in consultation with Dr. W. J. Otis. Her complaint was dull, aching pain in the epigastrium which had been present for eight months; pain under right shoulder blade, and on the inner side of both thighs but more severe in the left. She had slight burning with frequency of urination. The family history was irrelevant.

About a year ago she was operated for gall-stones but continued to suffer with the same symptoms as before. After a lengthy convalescence she was discharged from the hospital. She returned home but soon the pains became unbearable, with the additional discomfort of a post-operative hernia. She was admitted to the Charity Hospital and operated for hernia, adhesions and appendix. The second operation did not give any relief from pain. She now has fulness and feeling of being bloated after eating. Bowels move about once a week. For the past year the burning and frequency of urination has been steadily getting worse. No hæmaturia. Passes urine every two hours during the day and about six times every night. After the bladder has been emptied there is a dull pain over the suprapubic area. No headaches nor is she nervous. Cannot sleep. Palpitation on exertion with dyspnœa. Has been married twice; first husband died of apoplexy, second from heart disease. She has had no children nor miscarriages; menopause fifteen years ago.

* From the Fifth Urological Service of the Charity Hospital of New Orleans.

Physical examination reveals a well-developed adult female, fairly well nourished; skin pale, flabby, damp and cold. Hair gray, dry, brittle. Eyes react to light and accommodation. Ears negative; nose negative. Chest symmetrical, expansion equal, good, mucous râles over lower lobes, slight dulness over base of both lungs. Mitral murmur transmitted to axilla. Some enlargement of cardiac area of dulness. Abdomen shows right rectus and low median scar. Extreme tenderness over entire abdomen. No masses can be felt. Liver palpable. Extremities negative; genitalia negative; vaginal examination negative. Blood-pressure: systolic 140, diastolic 90. Urinalysis: no residual, cloudy in both glasses, heavy albumin, no sugar, hyaline casts, pus two plus, colon bacilli two plus. Two-hour 'phthalein: first, 20 per cent., second, 15 per cent., total 35 per cent. Blood chemistry: sugar 87, creatinine 184, non-protein nitrogen 35, urea nitrogen 17. X-ray of chest and gastro-intestinal tract negative.

FIG. 1.—Urogram showing bilateral duplication of renal pelves and ureters.

June 26th: cystoscopy under local anaesthesia. Urethra negative, bladder congested, ureteral orifices normal in appearance. After passing left ureter catheter a second orifice was noted about 1 cm. above and to the outer side. Both left ureters were easily catheterized with 6 F. catheters to kidney pelves. The right orifice was easily found and catheterized; a careful search failed to locate a second opening on this (right) side. Urines collected and urograms made which showed complete duplication of ureters and kidney pelves on left side. The urine from the upper pelvis was negative; from the lower: pus two plus and colon bacilli two plus. Urine from the right kidney was negative.

July 2: at cystoscopy indigocarmine was given intravenously and in four minutes was seen coming from both orifices on the left side; appeared from the right in six minutes. The two left ostia were catheterized with 5 F. catheters through the operating canal of a universal Buerger cystoscope. The orifice on the right was then catheterized with a 6 F. catheter through the left catheterizing canal. Dye was then found to be coming from above this right catheter and after much difficulty a second right orifice was located and catheterized with a 5 F. catheter *via* the right catheterizing canal. Urograms were made with a 25 per cent. sodium iodid; a print of the film is illustrated herewith in Fig. 1. The lower catheter on the right side became blocked with a blood clot and no iodid solution could be forced through. Urinalysis of specimen from upper pelvis on right was negative—as had been previously demonstrated with urine from

lower pelvis on this side. Lower left pelvis lavaged with 1 per cent. silver nitrate solution.

July 17: cystoscopy and left ureters catheterized and urines collected. 'Phthalein given intravenously; appeared from lower left ureter in 7 minutes and in 15 minutes excreted 7 per cent. From upper left ureter 'phthalein appeared in 10 minutes and in 15 minutes excreted 5 per cent. Lavage of lower pelvis with 1 per cent. silver nitrate solution. Urine shows less pus and bacteria and patient feels better.

July 26: cystoscopy and indigocarmine used to find right orifices. Dye appeared in 2 minutes from upper right ureter ostium and in 3 minutes from the lower. Both right ureters catheterized and urines collected. 'Phthalein intravenously appeared in 4 minutes from the upper right ureter and excreted 9 per cent. in 15 minutes; dye appeared from lower right ureter in 5 minutes and in 15 minutes excreted 6 per cent. Urines negative.

August 1: patient refuses further treatment and is gradually getting worse. On August 13 she died.

Autopsy showed marked sclerosis with calcified areas throughout aorta; enlarged heart with fatty degeneration of the musculature; mitral regurgitation. Lungs show passive congestion. Slight sclerosis of the liver. Many adhesions in gall-bladder region; gall-bladder has been removed. The omentum is bound down by dense bands of adhesions. The entire abdominal cavity has the appearance of former general peritonitis. Kidneys are very large, light in color, with two ureters from each kidney to bladder. The ureters on left side enter bladder separately while on the right they appear to be joined in a common sheath about three inches above the bladder wall. Ovaries enlarged and cystic; multiple intramural fibroids of uterus. Appendix has been removed. Clinical diagnosis: acute parenchymatous nephritis. Pathological diagnosis: arterio-sclerosis, myocardial degeneration, chronic nephritis, acute hypostasis of both lungs.

The specimen showing the bilateral duplication of the ureters and renal pelves was exhibited before the section on urology, Southern Medical Association, at their last annual meeting.

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PREHERNIAL LIPOMA

By Leigh F. Watson, M.D.
of Chicago, Ill.

Most so-called fatty hernias are simply isolated masses of fat, unattached to a sac, and I believe they should be called hernias only when they are accompanied by a peritoneal sac.

Lipomata are frequently found in the inguinal canal along the cord. Their lower portion is usually attached to the sac, and their upper portion is continuous with the properitoneal fat at the internal ring.

Fatty hernias in the inguinal canal can be seen as soon as the aponeurosis of the external oblique is incised. The mass is often lobulated and slightly vascular and it is sometimes surrounded by a thin cellular fascia which separates it from the other structures.

A lipoma in the inguinal canal that is adherent to the sac or cord is almost always attached to the properitoneal fat at the internal ring, and by causing a bulging into the canal, favors the development of hernia. The lipomata should always be removed at operation to lessen the danger of recurrence.

Fatty hernias are most often seen in young persons, but strangulation is more frequent in middle life, between forty to forty-five years of age. The peritoneal diverticulum that accompanies a true fatty hernia is usually rigid and inelastic, consequently it cannot hold a hernia and the examining finger enters the diverticulum with difficulty.

Strangulation is very rare. In the beginning of strangulation there is usually only a part of the lipoma beneath the skin in the subcutaneous tissues, and gradually more fat is forced through the hernial orifice by increased intra-abdominal tension or a sudden strain. When the peritoneal diverticulum attempts to pull back the intra-abdominal fat, the mass is caught in the ring; and it may become twisted, its blood supply obstructed, or it may rarely become strangulated.

The mass is seldom larger than a pigeon's egg, and with the onset of gangrene, it turns reddish-brown in color, and has a consistency similar to that of molasses.

Simple lipomas are ordinarily painless and cause no symptoms except the slight discomfort from their presence. When a fatty hernia makes traction on a peritoneal sac, it may produce pain and reflex symptoms which necessitate operative relief. This often happens when the hernia is in the linea alba. Pain is not so uniformly present in the other varieties.

There is generally a history of a fatty tumor having been present for some time before symptoms of strangulation develop. It is exceptional for strangulation to occur with the first appearance of the tumor.

The pain is most marked over the lipoma. The congestion and inflammation in the tumor are responsible for the general symptoms, such as nausea,

vomiting, abdominal distention, partial constipation or obstruction. However, these symptoms are not always present. In some cases the symptoms do not develop for some time after the appearance of the mass; in others, the symptoms are of sudden onset due to torsion or strangulation of the lipoma.

When the lipoma is strangulated, it is hard, painful and irreducible and difficult to differentiate from a small strangulated enterocele or omentocele.

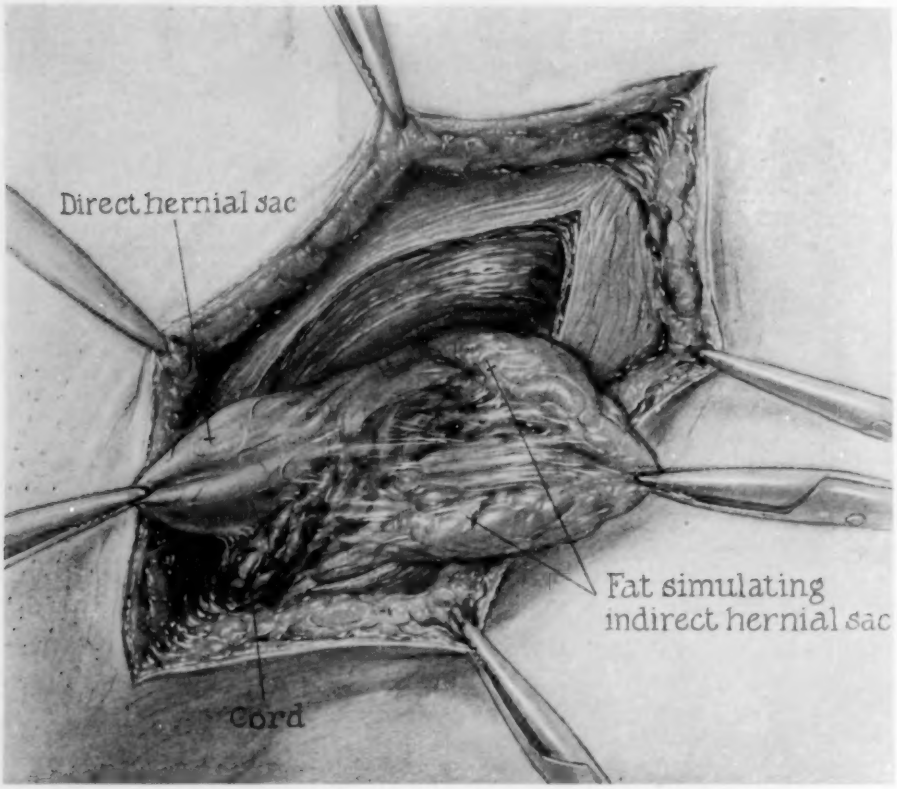

FIG. 1.—Prehernial lipoma complicating inguinal hernia.

In acute strangulation the symptoms develop slowly, usually in from four to six hours, and the typical symptoms are not well defined until about twenty-four hours later.

Diagnosis.—Diagnosis is most difficult when the tumor appears suddenly after a strain, with pain, more or less nausea, vomiting, abdominal tenderness, and meteorism.

Inflamed or strangulated fatty hernia must be distinguished from reducible, irreducible, and strangulated hernia of the intestine, omentum, or other abdominal viscera. Also from hernial peritonitis, strangulated partial enterocele, hernia of the vermiform, appendix, hernia of an epiploic appendix or Meckel's diverticulum, volvulus of the omentum or intestine, strangulation

of an internal hernia, intestinal obstruction, ectopia testis, epididymitis, orchitis, and adenitis.

Treatment.—Small fatty hernias without symptoms usually do not require treatment. When there is pain or reflex symptoms, operative treatment may be demanded. Large fatty hernias without symptoms may require operation on account of the physical inconvenience they cause, or as a preventive measure against the subsequent development of an enterocele or omentocele.

Before excising the fatty mass the operator must be sure that it consists only of adipose tissue. Injury to the intestine and omentum must be guarded against, and in the femoral and inguinal regions, the bladder, appendix, ureter, and a Meckel's diverticulum must be thought of. The peritoneal diverticulum must be entirely removed. After dissecting out and excising the lipoma, the peritoneal and fascial layers are sutured together and the hernia opening carefully closed.

THE VALUE OF BLOOD TRANSFUSION IN SURGERY OF THE PROSTATE

By Austin I. Dodson, M.D.
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Blood transfusion may be of special merit in the treatment of prostatic hypertrophy. These patients have reached the age when recuperation from injury is slow and many are additionally handicapped by anæmia and sepsis. By increasing the volume and quality of the blood, thereby improving the general vitality, blood transfusion is a most valuable adjunct to the pre-operative care.

In a series of 147 deaths from prostatectomy collected by J. B. Deaver, hemorrhage and shock occupy second and third places as causes of death. It is to combat these two fatal complications of prostatectomy that blood transfusion is of greatest help. The blood-vessels of many of these old men, because of sclerotic changes, are unable to adjust themselves to the rapid loss of fluid from the vascular system. There results a fall in blood-pressure which, unless the fluid volume is restored and maintained, frequently goes on to complete collapse and death. The volume may be restored by the infusion of saline or glucose solutions with very satisfactory immediate effect. In patients suffering from shock, these solutions—particularly saline solution—seem very rapidly to leak out of the circulation, and their value is often temporary. In hemorrhage these fluids lack the elements necessary to restore the blood cellular loss. They are very effective in combating the immediate dangers resulting from hemorrhage, but the old man is left to meet, in an anæmic condition, such pitfalls as sepsis and pneumonia which often endanger the convalescence of the patient recovering from prostatectomy. We have used 5 per cent. glucose solution by the method described by Matas (Matas, Rudolph: "The Continued Intravenous Drip," Annals of Surgery, vol. lxxix, p. 643, May, 1924) with a great deal of satisfaction in several cases. We believe this to be the most desirable means of administering infusions in cases of toxic exhaustion and dehydration, and in the treatment of shock and hemorrhage in young and robust patients whose natural recuperative powers can be counted on.

Transfusion of whole blood is, however, the most efficient restorative. It rapidly replaces the lost fluid, improves the quality of the blood, and, by decreasing the coagulation time, is a valuable asset in the control of bleeding. When used by the direct cannula method and when the blood is properly matched, transfusion is free from the disagreeable and sometimes dangerous reactions that often result from the introduction of foreign fluids into the blood. These reactions, while of little consequence in young or robust individuals, are a distinct handicap to the debilitated old men who comprise the

prostatic patients needing transfusion. It is for this reason that we have abandoned citrate transfusions. The direct method using the Bernheim cannula has been found most satisfactory, being almost entirely free from reactions and delivering the blood to the patient in its natural state. (Horsley, J. Shelton, Vaughan, W. T., and Dodson, A. I.: "Direct Transfusion of Blood," *Arch. Surg.*, vol. v, pp. 301–313, September, 1922.) In every instance in uncomplicated shock or hemorrhage, the blood-pressure has been rapidly restored and satisfactory recovery has supervened.

Our conclusion as to the value of transfusion of blood following prostatectomy are based on the following seven cases:

Case I.—Mr. W. W., seventy-five years of age, had hypertrophy of the prostate which was cancerous. A suprapubic prostatectomy was performed May 26, 1921. Sixty milligrams of radium were applied through the suprapubic wound and thirty milligrams through the rectum for eighteen hours. Immediately after operation the temperature was normal, pulse 90, and respiration 22. Two hours later the patient began to bleed profusely from the site of operation. His condition rapidly became critical. The pulse-rate increased to 160, and the blood-pressure was 75 systolic, diastolic not obtainable. He was transfused by the direct cannula method. The blood-pressure steadily increased until at the end of fifteen minutes of transfusion, the systolic pressure was 115, diastolic 85. The pulse-rate fell to 120. Following the transfusion there was some bleeding for only a short time. The patient is now symptom-free, four years after the operation.

Case II.—Mr. S. B. G., seventy-seven years of age, was operated upon April 22, 1922, for benign hypertrophy of the prostate by the perineal route. The patient left the table in good condition. Two hours after the operation he was found to be bleeding rather freely, necessitating reinforcing the packing. His pulse at this time was 100 and weak, his systolic blood-pressure was 90, diastolic 55, and the patient felt faint. Direct transfusion of blood was given for twenty-two minutes, after which his systolic blood-pressure was 108, diastolic 60. There was no further bleeding and recovery was uneventful.

Case III.—Mr. J. I. B., seventy-three years of age, was operated upon May 10, 1922, by the perineal route. A moderately large cancerous prostate was removed and sixty milligrams of radium were inserted in the wound and allowed to remain twenty-four hours. He left the table in good condition. His pulse was 118, systolic blood-pressure 130, diastolic 80. Two hours later the systolic blood-pressure had fallen to 95, diastolic 60, and pulse was 100. He was pale and his extremities were cold. There was very little loss of blood. His blood-pressure continued to fall until three hours after operation, when the systolic pressure was 70 and diastolic 20. At the end of a twenty-minute direct transfusion the systolic pressure was 115, diastolic 70. There was no further fall in blood-pressure and he made a satisfactory immediate recovery. He died twelve months later of a recurrence of the cancer.

Case IV.—Mr. R. W. C., sixty-five years of age, was operated upon by the suprapubic method for benign hypertrophy of the prostate, January 16, 1924. The patient left the table in good condition, his pulse 120 and of good volume. He did fairly well for about two hours when his pulse became weak, the systolic blood-pressure 100, diastolic not obtainable. Temporary improvement was obtained by the application of heat and by lowering the patient's head. Four hours after operation, his blood-pressure could not be obtained. After the administration of three grains of caffein, the systolic blood-pressure was 60, diastolic not obtainable. After direct transfusion for eight minutes the systolic blood-pressure was 90, diastolic 45. He continued to improve, and twelve hours later his systolic blood-pressure was 120, diastolic 60. He was discharged, well, forty-three days after operation.

CASE V.—Mr. R. B. M., fifty-six years of age, was operated upon by the suprapubic method for benign hypertrophy of the prostate, July 19, 1924. The patient left the table in good condition, systolic blood-pressure 132, diastolic 72, pulse 110. Six hours later his systolic pressure was 130, diastolic 80, and pulse 100. The following morning the systolic pressure had dropped to 110, diastolic 74, pulse 60. During the day his blood-pressure continued to fall and pulse-rate increased, until at 7 P.M. the systolic blood-pressure was 88, diastolic 58, and pulse 120. There had been very little bleeding and his hæmoglobin was 80. At the end of ten minutes of direct transfusion the systolic pressure was 110, diastolic 58, and pulse 100. Thirty minutes after the transfusion his systolic blood-pressure was 115, diastolic 60. The day following the transfusion his systolic pressure was 122, diastolic 70, pulse 88. His convalescence was uneventful.

CASE VI.—Mr. S. H. G., sixty-six years of age, was operated upon by the perineal route, February 23, 1925, for hypertrophy of the prostate which was cancerous. Sixty milligrams of radium were applied in the wound. He left the table in good condition. His pulse was 108, systolic pressure 124, and diastolic 70. The blood-pressure remained the same during the first twelve hours after operation, the pulse increasing to 120. The following morning the systolic blood-pressure was 126, diastolic 58, pulse 140. His temperature was 104, abdomen distended, and he was hiccoughing and vomiting. At the end of nine minutes of transfusion the blood-pressure was unchanged, but two hours later the systolic pressure was 130, diastolic 70. This improvement lasted only about five hours, when his blood-pressure began to fall again and he died forty-eight hours after operation, apparently from an overwhelming toxæmia or infection.

CASE VII.—Mr. A. S. F., fifty-nine years of age, was operated upon November 19, 1924, for carcinoma of the prostate by the perineal route. He left the table in good condition, with pulse 100, systolic blood-pressure 128, and diastolic 70. About three hours after the operation he began to show a considerable degree of shock, systolic blood-pressure 90, diastolic 50. He was relieved by the administration of 5 per cent. glucose solution intravenously, his blood-pressure steadily increasing until at the end of twelve hours his systolic pressure was 120, and diastolic 70. The following day his abdomen became distended and he was greatly distressed by constant vomiting and hiccoughing which persisted until his death. During this time his pulse varied from 108 to 120, his temperature was never above 100, and he excreted a satisfactory amount of urine. On the fifth day following operation 5 per cent. glucose solution was again given intravenously because of his inability to take fluid in any other way. When he had taken 200 c.c. of the solution he had a chill and the glucose solution was discontinued. Following the chill he was in collapse, systolic blood-pressure 100, diastolic 74, and pulse 140. After a transfusion lasting eight minutes his systolic blood-pressure was 112, diastolic 80, pulse 130. The improvement was only temporary and he died twelve hours later.

All of these patients were below the average as operative risks. The oldest was seventy-seven years old, the youngest fifty-six, and the average of their ages was sixty-eight years. Four had carcinomatous prostates and all of them some degree of arteriosclerosis.

In two cases transfusion was given because of hemorrhage, in two because of shock, and in three because of gradual failure of the circulation and inability to rebound. The four patients transfused for hemorrhage and shock were immediately relieved of their distressing symptoms and made uneventful recoveries. Of the three other patients, one recovered and two died. The patient who recovered showed no serious symptoms before transfusion except a gradual fall of blood-pressure and a feeling of weakness. He was transfused thirty-six hours after operation when his blood-pressure had fallen to 88 systolic, and 58 diastolic. He showed immediate improvement and made

an uneventful recovery. Of these five patients, one with a cancerous prostate died twelve months following operation from recurrence of the cancer. The other four, one of whom was operated upon for carcinoma of the prostate four years ago, are now in good health.

The two patients who were not benefited by transfusion had carcinoma of the prostate. In one of these patients (Case VI), sixty milligrams of radium in needles were inserted in the wound for twenty-four hours. He did well for twelve hours, when his pulse-rate began to increase and his blood-pressure gradually to fall. There was also a rise in temperature and he was greatly distressed by persistent hiccough, vomiting and distention. He was transfused twenty-four hours after operation with apparent temporary benefit, but died thirty-six hours later. The other patient showed considerable shock three hours after operation, which was relieved by the intravenous administration of 5 per cent. glucose solution. He developed marked distention, and vomited and hiccoughed continuously. Five days after operation he was again given 5 per cent. glucose solution intravenously because of his inability to take fluids otherwise. This was discontinued on account of a chill after 200 c.c. had been administered. A direct transfusion of blood was then given. There was only temporary improvement and he died twelve hours later, apparently a cardiac death.

It is evident from a study of these cases that blood transfusion is not a panacea for all the ills that befall the prostatic patient. The two patients who died gave evidence of a rather profound toxæmia. Both of them suffered from intestinal paresis, accompanied by vomiting and hiccough, and the pulse became rapid within a few hours after each patient left the table and remained so until he died. One of these patients (Case VII) suffered a considerable degree of shock immediately following operation, and although he responded to the intravenous administration of 5 per cent. glucose solution, it is possible that a blood transfusion instead would have given him a better chance. It is evident that our faith was too great in expecting benefit from transfusion after the patient was completely exhausted, nor have we a right to expect improvement when the patient has been overcome by a toxæmia or an infection.

Transfusion of blood is of great benefit as a general tonic to the anæmic, debilitated old man during his preparation for prostatectomy and in the treatment of shock, hemorrhage, and the general asthenic state following prostatectomy. The matching with the patient of suitable donors should be a part of the preparation for every prostatectomy.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held May 13, 1925

The President, Dr. Walton Martin, in the Chair

EFFECT OF MIXED TOXINS ON RECURRENT SARCOMA OF THE TESTICLE

Dr. William B. Coley presented a child who had a history of a trauma at twenty months of age, a few months prior to the appearance of a tumor in the left testicle which was first noticed in May, 1917, and which grew to the size of an orange in three weeks. Removal of the testicle at this time was done by Dr. D. P. Murphy, of Elmira, New York. Three weeks later a recurrence took place which grew rapidly and involved the glands of the groin. A second operation was performed by Doctor Murphy about two months after the first one. This, also, was followed by a rapid recurrence of still more rapid growth. The patient was referred to Doctor Coley October 19, 1917. Physical examination at that time revealed a tumor the size of two fists, extending down the thigh for a distance of six inches, the lower third of which was a fungating mass with a foul smell and discharge. The tumor, which did not extend upward beyond the external ring, was removed, and the wound was closed with skin from the other side of the scrotum. The patient was immediately put upon the mixed toxins of erysipelas and bacillus prodigiosus. (No other treatment.)

Pathological report by Dr. James Ewing (December, 1917): "The specimen is a round, solid, soft, elastic tumor mass, 7 x 8 cm.; it fungates through the skin over an area of 4 cm. wide, a portion of skin accompanying the specimen. On section the tumor is smooth, translucent, hemorrhagic along the fungating edge. It is circumscribed by an indistinct capsule. No portions of the testicle are visible in the single gross section. On microscopic examination the structure is composed of large and small groups of large polyhedral and spindle cells of indifferent embryonal type, consisting chiefly of hyperchromatic nuclei. These cell groups grade off into an abundant mucinous tissue of myomatous type and every gradation from polyhedral to star-shaped cells may be followed. Some cell clusters surround blood-vessels, which are not numerous. There are scanty small points of necrosis. The diagnosis is embryonal carcinoma of testis, with transition to pseudosarcomatous structure." Doctor Ewing, later reviewing this case stated, that the diagnosis "embryonal carcinoma," as given in his report, was an error, and that he regarded this as one of the very few cases in which he would make a definite diagnosis of "sarcoma of the spindle- and round-cell type."

The toxin treatment was continued at home by the family physician. In view of the marked improvement in the patient's condition, it was thought safe to discontinue the treatment at the end of a few months. About a year and a half later, another nodule the size of a pea, appeared in the neighborhood of the scar. This was removed and pronounced by Doctor Ewing to be of the same structure as the original tumor. The toxins were then resumed and

kept up for an even longer period than before. At the present time, seven years and eight months after the last operation, the patient is in excellent condition with no trace of a recurrence.

In view of the fact that frequent operations had failed to control the disease in this case it was only fair to credit the recovery to the prophylactic toxin-treatment. In a previous paper on "End-results in Malignant Disease of the Testis" (ANNALS OF SURGERY, September, 1923), Doctor Coley stated that, in 10 cases in which the toxins were used, alone in 9 cases and combined with radium in 1 case after operation in the hope of preventing a recurrence, 9 were living from 3 to 14 years after operation; and 4 were alive from 10 to 14 years later. Since the publication of this paper, one other case has gone beyond the three-year period of recovery.

SUBFASCIAL LIPOMA OF THIGH

DR. WILLIAM B. COLEY presented a man, sixty-two years of age. General health excellent. On March 5, 1925, he first noticed a swelling of the right thigh occupying chiefly the whole anterior portion. He paid little attention to it as it was not associated with much pain. The swelling continued to increase in size. He consulted a surgeon in Philadelphia, who regarded it as an inoperable fascial sarcoma and referred the patient to Doctor Coley for toxin- and radium-treatment.

Physical examination on April 20, 1925, showed marked enlargement of the whole thigh extending from Poupart's ligament to the upper border of the patella, downwards to the femoral vessels on the inner side, and well over the outer aspect of the thigh. The tumor was soft in consistence and had the typical "feel" of a multilobulated lipoma. The central upper portion of the tumor was of firmer consistence and simulated a sarcoma.

April 25, 1925, operative incision revealed a large tumor lying underneath the quadriceps muscle, extending down to the femur itself and internally in close proximity to the femoral vessels. The great bulk of the tumor had the typical gross appearance of a lipoma. The central and deeper portion was markedly adherent to the muscle, fascia, and periosteum, overlying the femur so that dissection was somewhat difficult. However, the entire tumor was removed *en masse* and the large wound was closed with drainage. The drain was removed at the end of forty-eight hours and the wound healed by primary union. Examination of the tumor after removal showed an apparently typical lipoma; however, in the central portion there was a rounded mass much firmer in consistence than the rest of the tumor, having the macroscopic appearance of a sarcoma.

Pathological report by Dr. F. M. Jeffries (May, 1925): "The growth from leg is a multilobulated lipoma with one hard nodule which, on further study and mature deliberation, I am convinced that we are here dealing with an inflammatory process alone."

Pathological report by Dr. Francis Carter Wood (May 21, 1925): "I have examined the three sections which you sent me. One is fatty tissue with a slight amount of lymphoid infiltration. The other two showed dense connective tissue with very much thickened blood-vessels, and again a heavy lymphocytic infiltration. I see no evidence of tumor. The thickening of the vessels, the peripherally arranged lymphocytes, and the general lymphoid infiltration, suggest syphilis—though I presume this has been excluded. In any case I should certainly not feel that the sections sent to me warranted a diagnosis of any tumor except a lipoma."

Doctor Coley said that the only other case in his experience that at all resembled the present one was admitted to his service at the Memorial Hospital several years ago. This patient, a middle-aged woman, had a tumor of six to seven years' duration, occupying the whole posterior portion of the thigh. Here, also, a diagnosis of fascial sarcoma had been made but the "feel" of the tumor suggested a lipoma. Operation revealed a lipomatous tumor weighing seven pounds. This patient was shown before the New York Surgical Society. The case presented this evening differs from the one just referred to in that the tumor was of shorter duration; but it is fair to assume that the tumor had existed for a much longer period than the patient realized.

Dr. Edwin Beer said that he had seen a number of arborescent lipomata somewhat similar to Doctor Coley's case, and one patient he had observed over a period of nine years who had a large lipoma of this type running in between the muscles apparently originating in the popliteal space. The patient was operated upon in 1916 for the original lipoma which recurred and was re-operated upon in 1922. At this time she was also operated upon for lipomata under the fascia in the right inguinal region and another one at the root of the neck. All specimens were reported lipomata. In 1924, the patient returned with another large recurrence in the popliteal space, which again proved to be an arborescent tumor running around the vessels and nerves in between the hamstring and flexor muscles as well as closely attached to the calf muscle. The tumor was removed with some of the attached musculature, and this time microscopic examination—though the tumor seemed identical macroscopically with previous tumors removed, showed "sarcomatous degeneration."

It would seem from this experience that some of these benign lipomata may undergo sarcomatous changes. Owing to their peculiar growth running in between various structures—muscular, vascular, etc., a complete eradication may be most difficult especially as during the dissection or enucleation, pieces of the neoplastic tissue are prone to be broken off from the main tumor.

SARCOMA OF TIBIA AND FIBULA

Dr. Guilford S. Dudley presented a man, fifty-eight years of age, who entered the Second Surgical Division of Bellevue Hospital, April 6, 1925. He had had pain and swelling in the region of his right ankle for the past year. His only history of trauma was of having "turned" this ankle three years previously. Restoration to normal followed three months of supportive strapping.

Examination showed a soft, rounded, smooth contoured, well-outlined swelling on the lateral aspect of the right ankle measuring about 6 x 4 x 2 cm. Its posterior border was in contact with the external malleolus. The skin was movable over the tumor, but the tumor was not movable upon the deep structures. There was no "egg-shell"-like crackle or evident enlargement of the superficial veins. There was considerable œdema of the entire lower leg, but no enlargement of the inguinal nodes or other evidence of inflammation. The X-ray showed two areas of bone absorption; one in the distal extremity of the tibia, and one in the distal extremity of the fibula. There were also visible a few calcific trabeculæ in the soft tumor mass. Chest X-ray showed a widening of the aortic arch, but no metastases. X-rays of the

remaining long bones showed no abnormality. The pre-operative diagnosis was "Giant-cell Tumor."

With a tourniquet on the thigh, he was operated upon on April 13, 1925. The palpable tumor consisted of brownish, friable, neoplastic appearing material encapsulated from the soft parts and the ankle-joint, but continuous with tumor tissue within both the tibia and fibula. The barrier between the tumor and the joint, however, was so thin that it was broken through in the attempt at removal, thereby exposing the lateral aspect of the joint. It was impossible to decide from which bone the neoplasm had primarily arisen. The tumor tissue within the bone did not resemble currant jelly, but was of a grayish-white granular appearance. Its removal left an ovoid cavity in the fibula 2 cm. in length and 1 cm. in breadth and a spherical cavity in the tibia 4 to 5 cm. in diameter. A thin shell of articular cartilage effectually excluded the tibial portion of the tumor from the ankle-joint. The cavities in the tibia and fibula left by curettage were treated with pure carbolic acid and alcohol, and the tourniquet removed. A rather profuse ooze of blood was disregarded and the skin wound closed without drainage. A culture taken from the tibia proved to be sterile. The wound healed by primary union.

Doctor Symmer's pathological report was: "Specimen consists of a piece of tissue measuring 5.5 x 4 x 2 cm. and about 50 to 60 smaller bits of various sizes. All present the same appearance and are yellowish in color and friable in consistence.

Microscopic: Sections show two types of growth. In one the prevailing cell is a fibroblast which appears to be a rather mature cell. In places this fibroblast appears to be capable of developing strands of mature connective tissue. Among the fibroblasts are considerable numbers of atypical multinucleated giant cells. One can make out here and there, in addition, small numbers of thin-walled apparently newly formed capillary vessels. In other places the ground substance is made up of mature looking fibroblasts scattered among which, in about equal numbers, are large giant cells of the type normally encountered both in the periosteum and endosteum; these cells possessing multiple well-formed, small, moderately chromatic, individual nuclei. In some of the sections, muscular and fatty tissues are to be made out and in the interstices are numbers of infiltrating tumor cells. If one depended on the histology alone to indicate the nature of the tumor and the prognosis, one would be inclined to say that the growth is non-malignant and the prognosis good. Histological signs of malignancy are notoriously unreliable, however. In the present case, taking into consideration the man's age, the fact that the tumor was soft, that at operation it was found to extend beyond the bony capsule, and that clinically and histologically there are signs of infiltration of muscular and fatty tissues, it seems to me that the tumor must be regarded as at least locally malignant and that local recurrence is to be expected. Although the question is one which requires exalted surgical judgment, it seems to be that amputation ought to be seriously considered since there is no reason to think that this tumor may not eventually metastasize to distant parts. Diagnosis: "Spindle- and giant-cell sarcoma."

Doctor Ewing, who saw the microscopic slides, stated that, in the absence of repeated surgical insults, metastasis would not occur although the lesion might recur locally. He advised against amputation.

The uncertainty of the outcome and the prolonged convalescence to be anticipated as the result of conservative measures were contrasted to the patient with the comparative certainty and lessened period of invalidism to be expected to follow amputation. He chose to have the leg removed. An

amputation through the middle third of the lower leg was done on April 25, 1925.

The case presents three unusual features: 1st, the age of the patient; 2nd, the location of the sarcoma; and 3rd, the apparent simultaneous involvement of two bones.

Dr. John A. Hartwell said that this patient illustrates the difficulty of diagnosing these cases and of knowing exactly how to classify them. Symmers doubts what terminology to give this disease, but Ewing believes it to be a benign tumor and that it will continue as a localized tumor if not subjected to surgical insult, as he calls it. It was to be hoped that this case would bring out a discussion as to whether it should be attacked surgically, or if one should trust to its being benign and only on the action of other curative agents than the operative. All surgeons have had good success with taking out such tumors and there has been some success with radiology. The diagnosis is almost impossible until the tumor has been cut into. If any of the members have had successful experience with other than the operative treatment, it would be interesting to have it repeated.

Dr. Wm. B. Coley stated that Doctor Dudley had given him an opportunity of examining the X-ray pictures and the slides before the operation; that he had advised conservative treatment with toxins and radium for a brief period before amputation, and that his reason for so doing was based on the fact that in a number of similar cases in which he had strongly urged amputation, but the patient refused to permit it, he had succeeded in effecting a cure by conservative treatment. Doctor Coley believed that two or three of these cases were of sufficient interest to justify mentioning them in this discussion:

Case I.—L. G., female, nineteen years old, was admitted to the Hospital for Ruptured and Crippled in October, 1914, with a swelling of the femur of four or five months' duration. In this case, not only the lower end of the femur was destroyed, but the whole knee-joint was involved. Amputation was strongly advised by Dr. V. P. Gibney and Doctor Coley, but the patient refused to have it done. While an exploratory operation was performed, no attempt was made to remove the tumor. Microscopic diagnosis by Doctor Ewing: Giant- and spindle-cell sarcoma of moderate malignancy. While this case is registered in the Bone-sarcoma Registry as a benign giant-cell sarcoma, a diagnosis of malignant tumor was made by Dr. Francis Carter Wood, as well as Doctor MacCarty and Doctor Broders of the Mayo Clinic. The patient received no other treatment than the mixed toxins of erysipelas and Bacillus prodigiosus, which was kept up for nearly a year. She made a complete recovery, and has remained well now over ten years. She was shown before a clinic at the Memorial Hospital several weeks ago.

Case II.—C. S., female, twenty-nine years old, was admitted to the Memorial Hospital in November, 1916, with a tumor which had completely destroyed the lower end of the femur, the knee-joint, and had also invaded the upper end of the tibia. Amputation had been advised by a surgeon at St. Vincent's Hospital, and in view of the extensive involvement of the disease, Doctor Coley believed there was little hope of saving the limb, and therefore, also, strongly urged an amputation; this, however, the patient refused. Doctor Coley then did an extensive curettage of the entire lower end

of the femur, the knee-joint, and the upper end of the tibia, packing the large cavity, and keeping it clean with Dakin's fluid. The wound healed without any infection. The toxin-treatment was begun on the second or third post-operative day, and kept up for three or four months. Just before she left the hospital, a steel needle of 100 mc. of radium was introduced through a small sinus which still remained, and left there for three hours; later on, a pack treatment was given externally. Within four months, the patient was able to get about without crutches, and within a year, the function of the limb was entirely restored and she was able to walk without any noticeable limp. She remained in excellent health until August, 1924, eight years later, when she died from hemorrhages following child-birth. Doctor Ewing's diagnosis in this case was giant- and spindle-cell sarcoma.

CASE III.—C. F., female, seventeen years old, was admitted to the Hospital for Ruptured and Crippled on July 22, 1915, with a tumor involving the upper five inches of the tibia; the knee-joint, however, was intact, a thin layer of cartilage still remaining. Amputation was strongly advised by Dr. Royal Whitman. It was decided to try conservative treatment first, so after a thorough curettage, the patient was put upon the mixed toxins. In January, 1916, the treatment was discontinued for a number of weeks, during which time the disease recurred and grew rapidly. A second curettage was done followed by a rapid recurrence. She was then treated with one massive dose of radium, the mixed toxins were kept up for a prolonged period. The patient is well at the present time, ten years later; she has complete restoration of function, and is able to walk without support of any kind. The diagnosis in this case was giant- and spindle-cell sarcoma; benign type by Doctors Ewing, and Bloodgood; malignant by Dr. George Barrie.

In view of these results, Doctor Coley believes that in most central tumors of the giant- or giant- and spindle-cell type, conservative treatment should be given a fair trial before resorting to amputation.

Doctor Coley stated that he should like to emphasize the point brought out by Doctor Hartwell that it was extremely difficult for the surgeon to determine the malignancy of a central giant- and spindle-cell sarcoma from the histological structure, as often experienced pathologists were unable to differentiate the malignant from the benign type.

Although Doctor Bloodgood in a paper entitled, "The Giant-cell Tumor of Bone and the Spectre of the Metastasizing Giant-cell" (*Surg., Gynec. and Obst.*, 1924, vol. xxxvii, p. 784), covering 70 cases personally observed and 100 cases collected from the Bone Sarcoma Registry, stated that he had never seen a metastasizing giant-cell sarcoma, Doctor Coley in his paper on, "Prognosis in Giant-cell Sarcoma of the Long Bones" (ANNALS OF SURGERY, March and April, 1924), covering 50 consecutive cases personally observed, reported 10 cases in which death had occurred from metastases. Doctor Coley added that since the publication of his paper he had observed three other similar cases in which death had occurred from metastases or extension of the disease. The results in these 13 cases had led Doctor Coley to regard the metastasizing giant-cell tumor as a real "spectre."

Doctor Coley stated it was only fair to mention that some of his early cases occurred many years ago when our knowledge of giant-cell sarcoma was considerably less than it is at present; on the other hand, a number of the

cases reported were of comparatively recent observation and had been examined both by Doctor Ewing and Doctor Bloodgood and had been pronounced by them benign giant-cell tumor.

In answering the question raised by Doctor Hartwell as to the best method of treating these cases, whether by radium or X-rays alone or by surgery combined with toxins, or X-rays, or radium, Doctor Coley cited the results obtained at the Memorial Hospital. At this institution, up to January, 1925, there have been treated 26 cases of giant-cell tumor with X-rays or radium; this includes 13 cases in which no previous biopsy or surgical intervention was employed; of these 13 cases only 1 patient has remained alive and well over three years. Of the remaining 13 cases in which X-rays or radium were used after curettage or exploratory operation, 4 are alive and well from three to five years (the limb was saved in three of these cases) 7 went on to amputation, and 4 are dead. In another group of 21 cases treated personally by surgery alone or surgery combined with toxins and radium, the following results were observed: 16 patients are alive and well from three to eighteen years (the limb was saved in 12 cases); in 9 cases amputation was performed (as a primary measure in 4 cases) and 3 are dead.

Doctor Coley stated that while future evidence may possibly show X-rays or radium to be the method of choice, the results thus far obtained have led him to the following conclusion: that, surgical treatment (curettage) followed by the use of carbolic acid or zinc sulphate, and then by the use of the mixed toxins, either alone or combined with radium, yields the best results. Certainly, the period of disability is very much shortened by the surgical treatment. Furthermore, the latter procedure permits a careful histological study of the structure of the tumor, which is a great advantage, and which is not possible in cases treated by X-rays or radium alone where the diagnosis is based upon clinical and X-ray findings. A study of the Memorial Hospital series shows that there had been an error in diagnosis in about twenty-five per cent. of the cases in which the diagnosis was based upon clinical and X-ray evidence.

CARCINOMA OF THE RECTUM

Dr. John A. Hartwell presented a man who had come under his care with the history of having been operated upon for cancer of the rectum by Dr. Arpad Gerster, at Mount Sinai Hospital, in 1884. The operation had been performed by the perineal route and a perineal anus formed. Doctor Hartwell stated that he had been unable to find a record of this case or to identify it in any of Doctor Gerster's writings. Dr. John Gerster has kindly looked through his father's records without success, so that the only knowledge of the pathological condition comes from the patient's statement that Doctor Gerster had exhibited him as a case of carcinoma of the rectum. The patient remained satisfactorily well, without undue trouble from the perineal anus, until about five years ago, when a prolapse began to develop. This gradually increased and he came to the hospital to get relief because of the incontinence which became worse, and the consequent mucus discharge which was present. He was operated upon on March 6, 1925, for this condition. Through a supra-pubic incision the prolapse was reduced by

traction on the recto-sigmoid. Four circular peritoneal layers of sutures were then taken around the pelvic peritoneum and the lateral walls in such a way as to fix the rectum within the pelvis. There were no evidences of any carcinoma either in the liver, the peritoneal glands, or about the rectum. It was difficult to determine how much of the rectum had been removed, but it was estimated that the recto-sigmoid had been drawn down some five or six inches. Except for a slight laxity of the mucosa, the operative procedure had cured the prolapse.

Doctor Hartwell presented three other cases of carcinoma of the rectum operated upon by himself, by the radical combined abdominal and perineal method. The first patient was operated in January, 1921, at the age of seventy-two. He had been entirely well until six months before that time. Then there developed a diarrhœa with blood in his stools and tenesmus at defecation. He had lost twenty pounds in weight, but in spite of this he was in reasonably good condition. Rectal examination revealed a crater-like ulcerating mass about four inches above the anus. At operation there was no apparent extension of the growth beyond the rectum itself, though at one point it had penetrated to the peritoneal coat. The operation was done in one stage by the well-established technic of mobilizing the lower sigmoid, ligation of the inferior mesenteric artery, and clearing out all the tissue surrounding the bowel as far down as the prostate. A peritoneal purse-string suture was then placed around the pelvic peritoneum, the bowel sectioned between two clamps and two ends inverted. The distal end was forced into the pelvis and the purse-string suture tied. The proximal end was brought out through a lateral McBurney incision from an artificial anus. The patient was then placed in the exaggerated lithotomy position, anus closed with a heavy purse-string suture and incision made backward from the perineum encircling the anus and ending over the coccyx. The ischiorectal fossæ were opened on either side, the levator ani muscles cut, and the dissection carried upward until the segment of bowel was entirely freed to the point where the abdominal dissection had ended. The remaining cavity was left wide open and packed with vaseline gauze. The histological growth was a malignant adenoma with definite gland alveoli infiltrating the submucous and muscular coats. Post-operative course was uneventful. Patient made a good recovery in every way and the large posterior wound healed rapidly. To date the patient is in excellent health, is working regularly, and has very little inconvenience from the colostomy.

Second patient, sixty-four years old, operated on March 7, 1924. His history had been similar to that of the first patient, but had only been of four months' duration. The cancer was seen by the proctoscope about 6 to 8 inches from the anus. Patient was in good general condition, his red blood-cells 5,300,000 and his Hb. 95 per cent. He had lost only ten pounds in weight. The operation was performed exactly similar to the one just described. There was, however, a great deal of difficulty in severing the sigmoid and rectum because of adhesions and the fact that the sigmoid was held well over to the right side, making a complex arrangement which was difficult to interpret. Patient, however, stood the operation well, but as a precaution was given 450 c.c. of blood at the end of the operation. His recovery was complicated by a severe infection in the abdominal wound, and an apparent connection between the peritoneal and pelvic cavities. He, however, recovered without undue delay, and at the present time is in excellent health, and the colostomy is functioning satisfactorily. The pathologist's report is adenoma destruens.

The third patient, age fifty-seven, was operated upon January 16, 1925. His history had extended over a period of ten months, with bleeding from the rectum. He was not in very good physical condition and showed marked constitutional evidence of the disease. Rectal examination showed the cancer to be about four inches from the anus and seemed to be of an encircling ulcerative nature. The operation was done by the same technic as the two previous ones, except that the colostomy was done in the midline. The comparison of these three patients does not seem to show that the midline colostomy has any advantage over the lateral position. It was found that the growth was rather closely adherent to the prostate, and in separating it a small rent was made in the urethra. This could easily have been closed, but it was decided that the introduction of a perineal catheter would not complicate the condition and would prevent overdistention of the bladder, which had occurred in a previous case. In that case the overdistention was not recognized until it had produced a pressure necrosis in the bladder wall, which in turn was followed by a gangrenous cystitis and caused the death of the patient. The presence of the perineal catheter in no way interfered with the healing of the wound, though there still remains a small perineal urinary fistula, which is continually growing smaller. Unfortunately the specimen in this case was lost between the operating room and the laboratory, so that no microscopical report is available. Examination at the time of the operation revealed a hard scirrhus carcinoma of an annular type about four inches above the anus, and extending upward from this for a distance of at least six inches was a hard pencil-like growth, which on section gave the gross appearance of carcinoma. Doctor Hartwell reported that he had seen one similar case in which the carcinoma as determined by the microscope had extended up the posterior wall of the bowel in this way for a distance of twelve inches. The possibility of such an extension is an important consideration in recommending the combined operation rather than the posterior alone. He was fully convinced that the combined operation with an abdominal colostomy was the operation of choice. In his experience he had been able to perform this operation always in one stage, the patient had stood the operation well, and with proper pre-operative preparation and a possible transfusion, he believed there were few cases in which the two-stage procedure of the operation was advisable. While there had been fatalities in his series, there was none in which the two stages would have lessened the danger. One fatality had resulted from anuria, one from gangrenous inflammation of the urinary bladder, and one in which the operation should not have been attempted as the cancer had involved the uterus and pelvis to an extent that made its removal impossible.

Dr. Edwin Beer said that in connection with the operation for carcinoma of the rectum—known as the Quenu operation, there were two important details which made for rapid healing and might be considered as an aseptic removal of the bowel. During the last few months he had availed himself of these and had been able to obtain an aseptic nearly primary wound closure and discharged the patients three to four weeks after the operation.

The technic referred to consists in cutting across the sigmoid through the working incision between two Payr clamps with a cautery; then the ends are inverted as the clamps are removed and the stumps iodinized. The proximal stump is brought through a gridiron incision in the left iliac fossa and left closed until distention compels the introduction of a tube, by which time

adequate union and protection of the wound in the iliac musculature has been effected. The lower stump inverted and iodinized in the same way is buried in the hollow of the sacrum and subsequently removed by a posterior incision after the anus has been circumcized and closed over with a flap of the adjacent cutaneous tissue. In this way the posterior incision is kept clean and the unopened gut with its contained new growth is removed in one piece with glands attached. This posterior incision in turn can be sewed up almost completely, leaving in only a soft rubber tube-drain in the hollow of the sacrum.

The second point that is referred to above, is the closure of the peritoneum in the floor of the pelvis. To avoid any peritoneal contamination from the posterior incision, a double layer of peritoneal sutures should be made, the deepest layer being continuous, and the more superficial of interrupted sutures which gives a broad approximation of the peritoneum across the floor of the pelvis and closes all the avenues of infection. For these two layers, chromic gut is used. The working incision in the median line or through the left rectus muscle is closed in layers and protected with collodion dressing.

Attention to these details has diminished greatly to the period of time that these patients spend in the hospital.

Dr. George Woolsey said he believed some of these cases were quite suitable for a Mayo modification of the Kraske operation, if one can reach with the finger the upper border of the tumor and it is a recent case. He has had several that have done well with this procedure except in one particular and that is that there is likely to be some sloughing of the lower end of the rectum, especially posteriorly. That leads to a moderate degree of stricture which can be readily treated. He usually does a preliminary colostomy and explores the abdomen through the incision. He agreed with Doctor Stewart that one should never operate without the consent of the patient to do a complete operation with colostomy if the conditions found make it necessary. In a recent case the sigmoid mesentery was so short that he could not have brought the sigmoid down, but because the tumor extended up so far the complete abdomino-perineal operation was done as the operation of choice.

Dr. Willy Meyer said that the combined operation is the operation of choice. The fact that such an ascending, pencil-like infiltration is sometimes found, makes it clear that a large portion of the gut should be removed and that cannot be done from below alone. The possibility of being able to palpate the liver, ligate primarily the inferior mesenteric artery and allow of pulling the sigmoid down as far as required, are the great advantages of the combined operation. To his mind it should be done in one stage if possible.

With reference to preparation of the patient: Many years ago it was recommended, if the tumor was not entirely obstructive, to avoid the establishment of an artificial anus by means of rather prolonged preparation. The speaker had followed this experiment in a number of cases and in many had succeeded in getting along without an artificial anus. The patients are daily

given larger amounts of castor oil followed by high colonic irrigations. This is carried out for four to five days previous to operation. During this time they are kept on a liquid diet and then laudanum is given the last 36 to 48 hours before operation. However, the majority of surgeons to-day prefer colostomy.

DOCTOR MEYER referred to two patients whom he had presented before this Society not long ago; one was operated on four years ago, the other three years ago. The former was in the early 30's, the other in the 50's. In both cases the tumor was well up in the pelvic colon and found to be attached to the posterior side of the uterus. The combined operation was done in both in one sitting, it being necessary to peel the tumor off the womb. The younger patient is entirely well to-day; the other one, in whom it might have been best to do a hysterectomy, had her condition been more promising, was treated with prolonged radiation, and is also alive and in a satisfactory condition to-day. The combined method is highly to be recommended and certainly represents the standard operation.

DOCTOR HARTWELL, in closing the discussion, said that he wished only to add that these cases with three others, making six in all, were the only cases that had come on his Division at Bellevue since 1914, that were in any sense operable out of a total number of 34. Two of these six were really not operable. In one an attempt was made to remove the tumor and the patient died the next day. The second was treated by one of the other members of the staff and died shortly after operation. Only 4 in the series of 34 were advisedly operable when admitted to the hospital. Two of the 34 were most favorably localized, but were inoperable because of infiltration of the liver, which had developed within approximately a month from the time the patients had had the first symptoms. If the patient is properly prepared, including a transfusion before operation, he will stand the operation in one stage without too much shock. The one-stage operation is preferable because of the difficulty of leaving the segment of bowel without leakage and danger of sepsis before the second operation can be done.

BOOK REVIEWS

THE SURGERY OF PULMONARY TUBERCULOSIS. By JOHN ALEXANDER, B.S., M.A., M.D., Assistant Professor of Surgery in the Medical School of the University of Michigan. With introductions by Hugh Cabot, M.D., Professor of Surgery and Dean of the Medical School, University of Michigan, and Edward R. Baldwin, M.A., M.D., Director of the Trudeau Foundation and Trudeau School of Tuberculosis and of the Saranac Laboratory for the Study of Tuberculosis. (Samuel D. Gross Prize, awarded 1925.) 8 vo. Lea and Febiger, Philadelphia and New York, 1925.

All who are interested in the treatment of pulmonary phthisis will find in this excellent work a wealth of accurate information, of logical conclusion and of reliable advice.

With the exception of the subject of therapeutic pneumothorax, every known surgical method of dealing with the lungs has been presented. The manner is most scientific and thorough. Nothing has been overlooked and no detail or sidelight has been omitted. Induced pneumothorax is discussed in a well-drawn comparison with thoracoplasty and other purely surgical procedures. In reaching a conclusion which favors thoracoplasty, Alexander wisely warns us that in determining these relative values, statistics are of little service, since the type of the disease and its severity varies greatly in the cases selected for each procedure.

To list all the purely surgical subjects which the author has covered would not be possible in a review; it is sufficient to repeat that nothing is missing and that each operative procedure has been viewed from all sides. Definition, introduction and development, indications and selection of cases, advantages and disadvantages, methods of technic, pre-operative and post-operative care and results, the latter often compared with those of other measures, all are treated in masterly style. There is a profusion of example and precept from the writings and statements of others each reference being accurately placed in an excellent bibliography. And always there is the conclusion of the writer, modest, yet with the stamp of authority.

To illustrate the scope of this big little book, phrenicotomy occupies 26 pages; extrapleural pneumolysis, 22 pages; tuberculous effusion and empyema, 15 pages.

As a human and personal touch there are portraits of a number of the pioneer workers in pulmonary surgery.

Alexander believes that in the United States, major operations for pulmonary tuberculosis should be performed in general hospitals rather than in sanatoria, and he deplores the restrictions commonly imposed on the admission of these patients to the public wards. The University of Michigan Hospital has established a fifty-bed division for the medical and surgical care of

phthisis pulmonalis and it is to be devoutedly hoped that other institutions may follow this worthy example.

Speaking of treatment preparatory to operation, the employment of digitalis to strengthen the heart is approved in spite of the dictum of the physiologists. But, after all, accurate clinical observations in disease are worth considering as well as the results of pure experimentation.

In the selection of operative measures the author gives preference in the majority of cases to the Wilms-Sauerbruch paravertebral thoracoplasty, although in selected instances different forms of surgical therapy may be indicated, such as other modes of thoracoplasty, pneumolysis and filling, and even the drainage of cavities. Pulmonary resection is particularly perilous and is only exceptionally to be recommended.

The thoracoscopy of Jacobaeus is regarded as of special value only when there are few and attenuated adhesions and satisfactory pneumothorax can be completed. As a rule, thoracoplasty is preferable.

The pictures well illustrate the various points of pathology and technic, the diagrammatic drawings being especially clear and explanatory. There is described and illustrated a composite raspatory devised by the author for simplifying the resection of ribs. The writer of this review can testify to the usefulness and convenience of this instrument.

Several tables and graphs showing results and accompanying conditions are useful for reference. Perhaps the most important one is that dealing with 1159 paravertebral thoracoplasties reported, 1918–1925.

In an introduction by Doctor Baldwin, there is reference to extraordinary difficulties under which this book was written—of these its pages give no hint and Doctor Alexander is to be congratulated upon the spirit which has achieved one of the highest literary honors of his profession.

HOWARD LILIENTHAL.

SOME FUNDAMENTAL CONSIDERATIONS IN THE TREATMENT OF EMPYEMA THORACIS. By EVARTS A. GRAHAM, A.B., M.D., Member of Empyema Commission, United States Army; Professor of Surgery, Washington University School of Medicine. Octavo, 110 pages. St. Louis, The C. V. Mosby Company, 1925.

This book records the most important advance in the treatment of acute empyema since the disease was recognized as a surgical condition. It is clearly and convincingly written and will be a lasting monument to the originality and resourcefulness of its author. Through the work of Graham and Bell which revolutionized the operative care of empyema during the influenza epidemic, thoracic surgeons accepted the new operative standardization in acute empyema. The present volume condenses all information so that within its few pages we have references beyond which it is hardly necessary to go.

There are four sections; the first, entitled "Pathology," deals mainly with the problem of open pneumothorax, its mechanics and the conclusions

drawn from carefully conceived experiment. The important lesson is taught that in the acute stage of empyema there must be no permanent open pneumothorax, however small. Finally, observation made during the epidemic of 1918 appears to have fully justified the author's logic. For example, the drop in mortality at Camp Lee from 48 per cent. to 4.3 per cent. Perhaps the most striking fact brought out is that both normal thoraces may be simultaneously opened with as little danger as one, provided the total area of the openings is not too great to prevent respiration—and the power to breathe under these changed conditions depends upon the vital capacity of the individual. Thus a vigorous subject with a high vital capacity can withstand a larger wound or wounds in his chest wall than one who is weak either by reason of congenital causes or because of disease, such as the pneumonia which usually precedes the empyema.

The importance of fixation of the mediastinum in operations upon the comparatively healthy pleura is stressed and the reasons for the safety of late thoracotomy for empyema is ascribed to the fixation of the mediastinal pleura by exudate. This is supposed to occur in two or three weeks after the beginning of the pneumonia, and may be assumed to exist when aspiration withdraws frank pus instead of opalescent fluid.

Graham does not agree with Elsberg's contention, that an animal with a thoracic wound will breathe more easily in the prone posture than in the erect or supine position. It must be remembered, however, that when a patient is prone, and supported by a pillow so that his lower ribs are elevated well above the horizontal plane, the pleura may be incised in its anatomically lowest part with little or no respiratory embarrassment. This appears to be due to the easy escape of the air through an opening which is now geometrically at the highest point and, perhaps also, because the phrenic movements with their powerful suction and expulsion are greatly limited in amplitude.

The other dangers of open pneumothorax—infection, circulatory disturbance and loss of bodily heat—are discussed. The importance of Dakin's fluid as a disinfectant is brought out.

In Section II. Graham deals with the Prevention of Chronic Empyema, a condition produced by fibrosis of the lung and by solid exudate, both interfering with pulmonary expansion. He rightly maintains that the best treatment is by the shortest method which will accomplish sterilization and obliteration of the diseased pleural cavity. He prefers a solution of the exudate by Dakin's fluid to mechanical decortication. Others, however, have found surgical mobilization of the lung necessary when the hypochlorite has failed. Graham seems to disapprove of permitting the chest wound to heal in the presence of an apparently sterile pneumothorax. Here many surgeons will differ, since in a large proportion of these cases, permanent cure with full obliteration of the cavity has been observed.

Section III is devoted to the importance of a high calory diet (3500) so as to improve nutrition. This and the advantages of the free ingestion of water are too little appreciated by the general mass of the profession,

and Graham has done well to emphasize the necessity of these adjuncts to convalescence.

Section IV is occupied by a discussion of a few matters not previously taken up. The treatment of pulmonary fistulas and the necessity for regarding them as possible outlets for suppurations within the lung are mentioned.

"When is an empyema healed?" is partly answered by the statement that numerous cultures should have demonstrated probable sterility before the opening may be permitted to close, and that healing may not be considered as secure for at least six months.

In an addendum, the author admits that owing to the thin and fragile canine mediastinum, dogs may not in all respects be suitable for experiments which bear upon human conditions. This may be true of surgery upon the healthy chest but it certainly does not invalidate the conclusions drawn from a study of empyema.

The greater part of Graham's work was done before 1920, the date when the S. D. Gross prize was awarded to the essay which forms the bulk of the book, and therefore many of its facts are familiar to thoracic surgeons. This does not, however, alter the value of the present volume but places it rather among those which should be found on one's library shelves.

HOWARD LILIENTHAL.

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